JOURNAL

VOLUME 84

FEBRUARY
1960

Journal Subscription
30s. per annum (post free)
3s. 6d. per single copy.

THE ROYAL INSTITUTE OF CHEMISTRY

PAGE

The Institute is not responsible for individual opinions expressed in articles and reviews or in reports of lectures and discussions. Editorials do not necessarily express the views of the Council.

THE ROYAL INSTITUTE OF CHEMISTRY, 30 RUSSELL SQUARE, LONDON, W.C.1
Museum 1761 - 2

CROP NUTRITION AND THE WORLD FOOD SUPPLY

We seldom pause to think that nearly every bite of food we eat and most of the clothing we wear takes something from the soil. The timber crop also takes its toll. But that is not the only way the soil is being impoverished. In humid regions, large quantities of plant food are washed out of the land every year by rain and, in many parts of the world, some of the soil itself is continually being lost through erosion.

Can Nature make good these losses and enable us to feed and clothe a rapidly increasing population? Rain, sun, wind and frost break down particles of rock, plants and animals die and decay, earthworms and other members of the soil fauna play their part and new soil is formed, but the process is very gradual.

In most parts of the world there was no problem a century or two ago. There were fewer people and, as much of the food was consumed on the farms and in neighbouring villages not blessed with too much sanitation, a good deal of the plant nutrients went back to the land as manure. Today, however, with the concentration of the population in large cities and modern sanitation, much of the fertility of the fields finds its way into rivers and the sea.

Little more than a hundred years ago farmers depended mainly on animal manure for the nutrition of their crops. Composts, bones, wood ashes and seaweed were also used and lime, chalk and marl applied as soil improvers in some areas. Land was often rested for a period under grass, and bare fallowing was practised, not only to get rid of weeds but because a better crop was obtained the following year.

From very early times there had been speculation about plant growth and the general conclusion was that 'corruption is the mother of vegetation' and that plants fed on humus in much the same way as animals fed on plants. During the Thirty Years' War when there was a shortage of animal manure because of the slaughter of stock for food, Glauber suggested 'Philosophic Dung' or 'Fattening Salt', composed of wood ashes, lime, putrefied materials and saltpetre, to restore fertility and this was perhaps the first fertilizer to be concocted.

De Saussure and Boussingault brought a more scientific approach to the problem and, largely on the basis of their work, Liebig propounded his mineral theory of plant nutrition, and an artificial manure known as Liebig's Patent Manure was put on the market. It contained potash and phosphate but no nitrogen and the phosphate was unfortunately rendered insoluble by fusion with lime; it was not a success.

Meantime John Bennet Lawes had commenced his celebrated experiments at Rothamsted. In 1842 he patented a process for the manufacture of superphosphate, a water-soluble phosphatic manure, and set up a factory to produce it. This marked the birth of the vast fertilizer industry and revolutionized crop production not only in Britain but throughout the world.

Farmers did not at first take very kindly to the new-fangled manures out of bags but, by the outbreak of the first world war, the U.K. was using 230,000 tons of fertilizers in terms of N, P_2O_5 and K_2O, and the figure had risen to 300,000 tons by 1939.

Since then there has been a phenomenal increase in the use of fertilizers here and in many other countries. In the U.K. the consumption is now over a million tons annually in terms of plant nutrients, and British farmers are using about five times as much nitrogen and potash and twice as much phosphate as they did 20 years ago.

The reasons are not far to seek. The area of arable land has been increased, crop production intensified and new varieties of cereals have been introduced which withstand heavier dressings of nitrogen without lodging. Cash cropping removes far more nutrients than the more leisurely system of stock farming and the losses must be made good if the land is not to be impoverished. Since 1939 food production in this country has risen by more than 60 per cent, and we are now growing about half our food requirements compared with a third before the war.

The same kind of thing has been happening in many other countries, but, in the past, it has been hard to get a world picture of the use of fertilizers and its effect on farming. Fortunately in 1952 the Food and Agriculture Organization produced a useful publication, *Efficient Use of Fertilizers*, which goes a long way towards meeting the need, and a revised and enlarged edition has now been issued.*

Like the curate's egg it is good in parts. It suffers from having 99 contributors and the first drafts of its 11 chapters were done by no fewer than 16 writers, singly or in groups. That the overall result is so good says much for the editors. They must have had a wonderful time with the blue pencil but one wishes occasionally they had used it more.

The book covers a wider field than the title indicates, touching as it does on fertilizer raw materials and their sources and on processes of manufacture. There is also a longish chapter on 'The necessity for organic matter

* *Efficient Use of Fertilizers*. Edited by Vladimir Ignatieff and Harold J. Page. Food and Agricultural Organization of the United Nations, Rome, 1958. London: H.M.S.O., 20s.

and the preparation and uses of organic manures'. No chances are taken with the scientific background of the reader; ions and pH are explained and water has a narrow escape. The reason doubtless is that the book is meant to help agricultural planners. It will also be of value to agricultural advisers, teachers and students but the information is too generalized for farmers.

In the chapter on 'Commercial fertilizers and soil amendments', much attention is given to the sources of plant nutrient materials. It is comforting to learn that there are such large known reserves of mineral phosphates widely distributed throughout the world, and vast regions where a search has not yet been made.

The provision of unlimited supplies of nitrogen from the air is a question of steel and power, and when other sources of potash become exhausted potash fertilizers can be obtained from sea-water, but the supply of phosphate fertilizers may, one day, present a problem.

Methods of manufacture are outlined and one is impressed by the wide range of products now available to the farmer. It is interesting to note, however, that two of the oldest, superphosphate and sulphate of ammonia, are still the most widely used. A great deal of nitrogen is now supplied as ammonium nitrate and the use of urea is increasing.

Anhydrous and aqueous ammonia, often mixed with other soluble materials such as urea or ammonium nitrate, are now used extensively in America in the manufacture of mixed fertilizers. They are also applied directly to the soil. It has been shown that they are as effective as solid fertilizers but there are drawbacks as well as advantages, and much depends on the cultivation methods and cropping practices.

Reference is made to the improvement in the physical condition of fertilizers through granulation and to the increasing trend towards the production of fertilizers of high plant-nutrient content. These concentrated products, which are usually based on such materials as triple superphosphate, ammonium phosphates, ammonium nitrate and urea, save costs in handling, transport and application.

Fertilizers made from urea and formaldehyde, which have a low solubility in water, are now produced in America and probably elsewhere. They release nitrogen slowly and are useful for certain crops, especially those with a long growing season.

The soil, climatic and other factors affecting the use of fertilizers are discussed at considerable length, and there is a section dealing with the various nutrients, including micronutrients, required in addition to nitrogen, phosphorus and potassium. Deficiencies or excesses of these substances are relatively uncommon in Britain but in many parts of the world they affect both crops and stock. In this country a troublesome disease in stock known as hypomagnesaemia or grass staggers is associated with low uptake of magnesium by the animal, and one of the causes appears to be lack of proper balance in crop nutrients.

There have been great changes in recent years in methods of applying fertilizers, and broadcasting them on the surface is being largely superseded by 'placement'. The fertilizer is applied in pockets or continuous narrow bands along with or close to the seed at sowing time. This results in higher crop yields and economy in fertilizer. Other methods discussed are top-dressing by aircraft, the application of fertilizers in liquid form, deep placement for wet paddy and foliar application.

Liming and the treatment of alkaline soils are also dealt with and there is a brief reference to the use of synthetic polyelectrolytes as soil conditioners. The latter are effective in preserving soil structure against deterioration but not creating it, and they are so costly that their use is confined mainly to glasshouse soils or other soils which yield a very high income per unit area.

There is a chapter dealing with cropping systems and farming practices in various countries in relation to fertilizers and animal manures and there are sections on monoculture and on green manuring, cover crops, mulches and crop residues.

An interesting account is given of plant nutrients in the podzols, chernozems and other broad soil groups of the world. The relationships are necessarily very general for every group contains a whole range of soil types which may differ markedly in natural or potential fertility. Much more progress has been made in developing, for agricultural use, even the less tractable soils in temperate regions than soils in the tropics. Tropical soils are a challenge to the soil scientist and the agriculturist and, although some of the methods which have been successfully employed on the soils of temperate regions are applicable, new techniques are urgently required.

An evaluation is given of the world's soil resources and a guess is made that the estimated 1,000 million hectares at present in agricultural use could be increased to about 1,750 million hectares if the soil management practices already known were effectively applied. It is also pointed out that production on much existing farm land could be increased by 50 to 100 per cent on the basis of existing knowledge if the cultivator had the necessary skills and materials.

There is a long section on the soil and nutrient needs of all the principal crops. This is naturally very general but it contains much interesting and useful information not readily available.

The final chapters deal with the economics and public-policy aspects of the use of fertilizers and with the ways in which the various government and other agricultural services assist the farmer. These will be of special interest to the administrators and planners but the book as a whole can be commended to a wide circle of readers interested in food production. W. G. OGG

THE CROWTHER REPORT AND THE TECHNICAL CHALLENGE

The beginning of the 1960s will be marked by the publication of three important reports on education. One of these has already appeared. This is the Report of the Central Advisory Council for Education (England)—the Crowther Report—which outlines a 20-year programme for the education of young people aged 15 to 18 (Vol. I now obtainable from H.M.S.O., price 12s. 6d. net). A Report on the Youth Service, produced by the Albemarle Committee, will be published in February,* and the Anderson Report on students' grants is expected later in the spring. It is perhaps coincidental that these three reports will appear within a few months of each other, but it does show the increasing importance of educational affairs in the national life.

The report of the Crowther Committee has been heralded as the greatest contribution to the education of the adolescent since the Hadow Report (1926). A significant publication it undoubtedly is, but it is only fair to point out that the parts of the Report that have hit the headlines in the national press—the raising of the school-leaving age to 16 and the introduction of County Colleges—were incorporated in the 1944 Education Act. The Crowther Committee has, in fact, restated those clauses of the Act that have not yet been implemented and has reiterated their importance.

The practicability and desirability of raising the school-leaving age to 16 have already been much debated and discussed. It is stated in the Report that by the mid-1960s about half the pupils in secondary schools will be voluntarily staying on to at least the age of 16. This proportion could probably be raised to two-thirds—given an adequate supply of good teachers. The question then arises as to whether the remaining one-third would really benefit, either themselves or the community, by remaining at school until the April or July after they reach their 16th birthday (they could in fact be 16½ years old when they leave). Might it not be better for these pupils to continue their education on a part-time or block-release basis at a technical college or county college, in which they would have a more adult environment?

Everyone knows something about schools, and most people know a little about universities, but technical education remains to a large extent the preserve of those who practise it. Perhaps this is the reason why the section of the Report on 'The Technical Challenge' has received so little publicity, despite the fact that Sir Geoffrey Crowther himself has said that he believes this section to be the most important. The introduction to this section describes technical education as a 'territory, as yet largely unmapped, which offers rich rewards for careful cultivation.' The long-term aim, says the Report, should be to transform what is now a varied collection of plans for vocational training into a coherent national system of practical education with the progressive replacement of part-time courses for technicians and technologists by full-time or sandwich courses. The Report recommends that the proportion of young people in the age range 16-18 years who receive full-time or sandwich-course education should be raised to 50 per cent within the next 20 years. This is indeed a challenge, since the proportion in the 16-18 age group in full-time education is now only about 1 in 8.

The Committee is rightly appalled by the 'wastage' in craft and technician courses. Of all students entering a National Certificate course without exemption, only 26 per cent eventually obtain an O.N.C., and 10 per cent a H.N.C.; only one student in 30 climbs the National Certificate ladder from bottom to top without having to repeat a year. The Report, however, goes a long way in suggesting how to put this matter right. Among the suggestions are: greater integration between the schools and further education establishments, so that transition can be made from one to the other smoothly and without loss of educational momentum; more time for the course to be completed properly and without strain; an experimental full-time induction period of, say, one month, in order to assess the students' capacities and capabilities and to ensure that any particular student is enrolled in the right kind of course.

What the burden on industry will be if the recommendations of the Crowther Report are implemented it is impossible to say. Industry will certainly have to bear the cost of block-release and sandwich courses, and it is bound to be high. It is a pity therefore, that although there is a fairly precise calculation of what the Report's plans will cost the Government there is not even a guess as to what they might cost industry. Yet if the burden is inescapable it ought to be known and taken into account by industry so that the plans may be accepted by all interested parties and their implementation may go through smoothly.

In the Section of the Report on 'The Sixth Form' the Committee endorses the principle of specialization, or study in depth, in sixth forms, but is unhappy about some of its features, for example the heavy demands of the specialist curriculum of the science sixth.

It is impossible not to be impressed by the scope of the Report and by the extraordinary amount of work involved in preparing its 500 pages. It is an objective survey which concentrates on important issues and directs attention to points where the debate sought by the Minister is likely to be most fruitful.

D. G. Chisman

* Since available.

PHYSICS IN THE SERVICE OF CHEMISTRY

OPTICAL ROTATORY DISPERSION

By W. KLYNE, M.A., D.SC., PH.D., F.R.I.C.

Reader in Biochemistry, Postgraduate Medical School, University of London

Optical rotatory dispersion means the variation of the rotatory power of a substance or solution with the wave-length of the incident light. The purpose of this review is to discuss the application of optical rotatory dispersion measurements in chemical problems; theoretical aspects will not be considered.

The use of dispersion measurements on an extensive scale is very recent. This sudden growth of the subject is due to the introduction of a commercially available photoelectric spectropolarimeter, which permits the rapid determination of dispersion curves. It is hoped that the development of automatic recording polarimeters will make possible even more rapid advances in the future. The present state of knowledge in this field is outlined fully in a recent book by the leading modern worker, Djerassi.[1] Other reviews,[2,3,4] giving more detail than the present survey, are available.*

Rotatory dispersion measurements are of value only for asymmetric compounds; this means that they are chiefly of use in those parts of organic chemistry (and biochemistry) which deal with natural products—since most of these are asymmetric—and with synthetic compounds possessing biological activity (drugs, insecticides, plant growth substances and so forth). The importance of this field must not, however, lead us to overlook the value of dispersion measurements in dealing with problems of reaction mechanisms, and with the study of asymmetric inorganic compounds, especially co-ordination complexes.

In this review most statements refer to organic compounds of small molecular weight—up to 1000. A few comments on macromolecules and inorganic compounds will be found at the end.

APPARATUS

A spectropolarimeter consists of the following parts: (*a*) light source, (*b*) monochromator, (*c*) polarizer, (*d*) cell for material studied, (*e*) analyser, (*f*) means for measuring directly or indirectly the rotation of the plane of polarization, (*g*) (preferably) an automatic recorder which plots rotation against wave-length.

Chief interest centres on the means of measuring the rotation; the following very condensed account is necessarily incomplete, since many of the instruments mentioned are still in the prototype or development stage. The devices fall into three classes.

(1) *Mechanical movement of one of the optical components.* In the first and simplest instrument, that of O. C. Rudolph[5] (Caldwell, N.J.), the analyser is adjusted manually to measure the rotation, in the same way as with the ordinary classical polarimeter. The curve must be plotted point by point, but this can be done in ½-1 h, depending on the number of points plotted.

Two automatic recording polarimeters operate on similar principles to the above. In the Rudolph recording spectropolarimeter[5a] the polarizer is rotated to compensate for the sample rotation, and the angle through which the polarizer is turned is plotted mechanically against wave-length. In the Unicam instrument (which is based on the Glaxo design, *see* below) one of a pair of Wollaston prisms is rotated for the same purpose.

(2) *Sample rotation balanced by Faraday effect.* In several types of polarimeter the sample rotation is compensated by an equal and opposite rotation produced electromagnetically in a Faraday cell. The current necessary to produce the balancing rotation is related to the angle of rotation (Gillham,[6] Gates,[7] Grosjean *et al.*[8] (Roussel); also Cary and Zeiss instruments in preparation).

A spectropolarimeter under development at the National Physical Laboratory, Teddington, employs Faraday Cell compensation. The instrument itself, however, is of novel design, in that two crystalline quartz prisms are used, each serving a dual purpose, acting as disperser of the radiation and at the same time as polarizer or analyser.

(3) *Symmetrical angle principle.* Difference in intensity of two beams polarized in different planes. If two beams polarized in different planes (angles, $\pm\,\theta$ to a zero plane) are passed through an optically inactive material and then through an analyser set in the zero plane, the intensities of the two beams are equal. If now an optically active sample is put in place of the inactive material, the planes of vibration of the beams emerging from it will be at angles $(+\,\theta + \alpha)$ and $(+\,\theta - \alpha)$ to the zero plane; when these have passed through the analyser in the zero plane, their intensities will *not* be equal, and the ratio of their intensities will be related to α, the rotation of the sample. The measuring problem resolves itself into the measurement of a ratio of two currents (when the two beams fall on a photocell). Several newer polarimeters depend on this principle, the two beams being separated 'in time' (by putting the $+\theta$ and $-\theta$ beams through the sample alternately) or

* This survey includes some sections that follow very closely the author's fuller reviews[3,4].

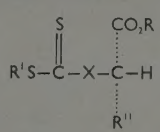
'in space' (by putting the two beams through two identical samples). Examples of the first type (time) are the instruments of Günthard[9] (Zürich), Fordyce, Parker and Green[10] (Glaxo); of the second type (space) those of Perkin-Elmer[11] and Woldbye.[12]

As the Rudolph polarimeter is the only one in general use, the following data on performance refer to this instrument—range, 700 to 270 mμ (or sometimes 250 mμ); sample tube, may be micro-tube, 1 dm length, < 2 ml capacity, or larger tubes up to 4 dm can be used; precision for actual observation, about 0·002°; concentration of solutions may be 1 mg/ml or less; accuracy of molecular rotation (compound of mol. wt 400, in 1 dm tube, 1 mg/ml) about $\pm 10°$.

TYPES OF DISPERSION CURVE[2]

The general principles relating rotatory dispersion and structure have been known for many years (for reviews of classical work, *see* ref. 13). For most compounds which do not absorb light within the range of wavelengths studied, the magnitude of the rotation increases steadily with decreasing wave-length. For compounds which do absorb within the region studied, the curves are much more complicated, often showing one or more maxima and minima in the neighbourhood of the absorption bands.

It is possible to measure the optical rotation of a substance right through an absorption band only if the absorption band is in an accessible part of the spectrum, and if the extinction coefficient is low. Up to the present the carbonyl group (λ_{max} at 280-300 mμ; $\epsilon \sim 50$) has proved the most convenient absorbing group which fulfils this specification. Compounds containing a ketonic or aldehydic carbonyl group in an asymmetric environment (but not acids, esters or lactones) give rotatory dispersion curves with very pronounced 'maxima' and 'minima.' Other types which have



(I) X = O or NH

been less used to date are nitro compounds (RNO_2), nitroso-compounds (R·NO), and thiocarbonyl derivatives[14] of α-amino and α-hydroxy acids (I).

CLASSIFICATION[15]

Plain curves. These show no maximum or minimum within the wavelength range studied—or only a broad maximum or minimum *not* associated with an absorption band (*see* Fig. 1). They are called *positive* or *negative*, according to whether the rotation becomes more positive or more negative as one goes from longer to shorter wavelengths.

Cotton-effect curves. These show one or more maxima or minima at wavelengths associated with an absorption band. The geometrical maxima and minima associated with an absorption band are termed 'peaks' and 'troughs' (*e.g.* points P and T in Fig. 2).

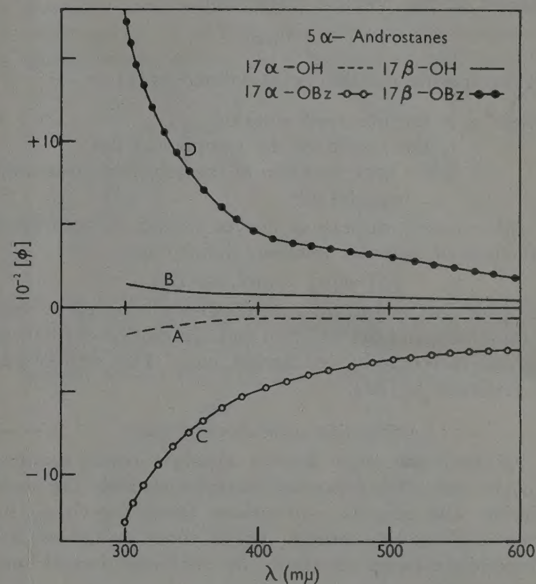


FIG. 1. Plain curves. All in methanol solution. A, 5α-androstan-17α-ol; B, 5α-androstan-17β-ol; C, 5α-androstan-17α-yl benzoate; D, 5α-androstan-17β-yl benzoate (*cf.* Jones, P. M., and Klyne, W., *J. chem. Soc.*, in press)

Curves are called positive or negative according as to whether the major feature of longer wavelength is a peak or trough. In Fig. 2 curve A is positive, B is negative.

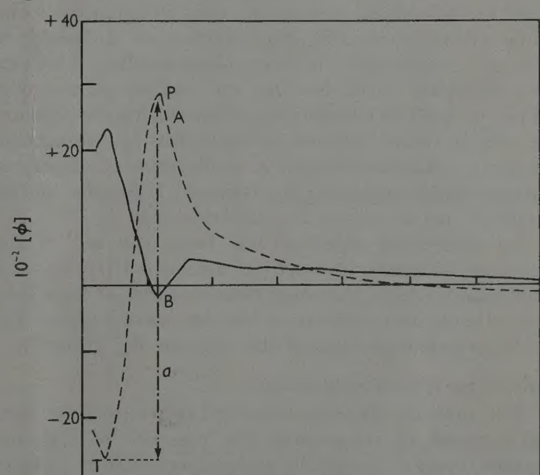


FIG. 2. Saturated ketones (i); Cotton-effect curves, illustrating differences due to stereochemistry; (solvent, methanol). A, 5α-cholestan-3-one; B, 5β-cholestan-3-one

The algebraic difference between rotation values for the peak and trough of a Cotton-effect curve is called the amplitude (symbol a; see Fig. 2; generally expressed in tables as $10^{-2}a$). The sign of the amplitude is as defined in the previous paragraph.

UNITS

The specific rotation $[\alpha]$ is defined as $[\alpha] = \frac{100\alpha}{lc}$

where α is the observed rotation

l is the length of the sample (in dm)

c is the concentration of the solution (measured in g/100 ml).

All rotatory dispersion curves should be expressed in terms of *molecular rotations*, defined as

$$[\phi] = [\alpha] \times \text{mol. wt}/100,$$

in order that quantitative comparisons between related compounds, and the addition and subtraction of rotation curves, can readily be carried out. The symbol $[\phi]$ is preferred to $[M]$.

FORMULAE AND CONVENTIONS

All formulae show known absolute configurations. Acyclic and cyclic formulae follow respectively the usual Fischer and steroid conventions (now known to be correct in absolute terms). Bonds above and below the plane of the paper are shown by thick and dashed lines respectively.

APPLICATIONS

Quantitative Analytical Uses

Some potential analytical uses are obvious for any property which is directly proportional to the concentration of a given substance X in solution. Since the molecular rotations of many compounds may be up to 100 times greater in the region of an absorption band than at the sodium D line, the gain in accuracy to be obtained by measuring the rotation at a 'peak' or 'trough' wavelength is very considerable. Methods can doubtless be devised for the analysis of mixtures of more than two components by measuring the rotation at two or more selected wavelengths (*cf.* absorption spectra). Another analytical application of dispersion measurements suggested by Djerassi[1] is for the kinetic study of reactions such as epimerizations.

An interesting side-line has been the use of the spectropolarimeter to 'uncover' optical activity in some compounds which have negligible rotations at the D line, but considerable activity at shorter wave-lengths (*e.g.* a degradation product of the vitamin B_{12} group[15]).

Recognition of Functional Groups

The rotatory dispersion method can clearly be used as a means of recognizing the presence of carbonyl groups (even if chemically rather inert). In most cases it will serve merely to confirm the results of infra-red spectra, but there are a few special cases where the dispersion curve might be uniquely valuable. For example, the carbonyl groups of cyclopentanones a[nd] of acetoxyl groups absorb at nearly the same freque[ncy] (~ 1740 cm^{-1}). In a compound containing an aceto[xyl] group and *inert* cyclopentanone carbonyl, the dispers[ion] curve might be the only simple way of detecting [the] latter.

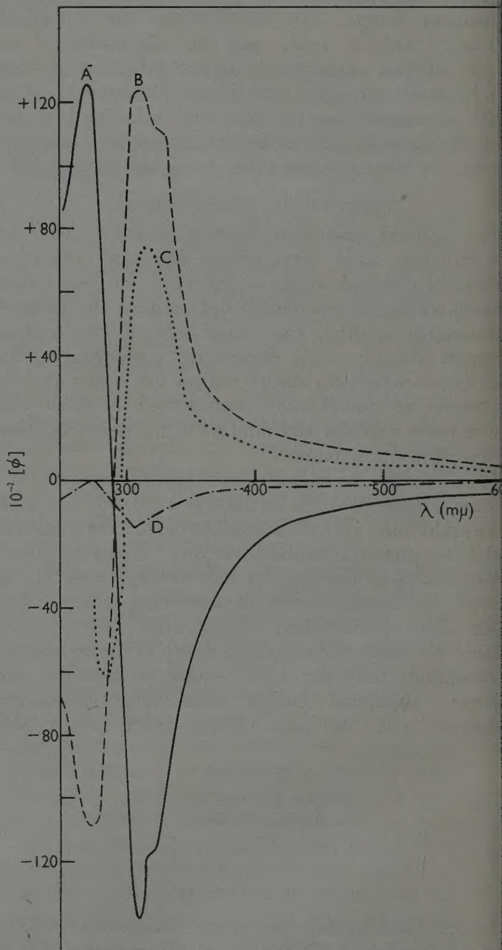


FIG. 3. Saturated ketones (ii), solvent methanol, unless sta[ted] otherwise; Cotton-effect curves, illustrating (*a*) the idea[l] enantiomeric types; A, 3β-hydroxy-5α-androstan-16-one; [B,] 2-oxo-5α-A-norcholestane, (*b*) differences in amplitude due [to] position of keto group; C, 5α-androstan-17-one (in dioxa[ne]); D, 3β-acetoxy-5α-cholestan-7-one

(Taken from ref. 4 by kind permission of the publish[ers;] original curves by Djerassi *et al.*)

Location of Functional Groups (*carbonyl groups*)

In a series where adequate reference curves a[re] available, the dispersion curve of a new compound m[ay] often give information which could not be obtained wi[th]

any other physical tool. Thus among steroid ketones (formula II) nearly every position has its characteristic type of 'wave'—as illustrated by Figs. 2 and 3 and Table I.

TABLE I

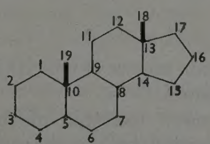
ROTATORY DISPERSION CURVES OF SATURATED STEROID KETONES

All results from Djerassi *et al.*[1] Solvent, methanol. Amplitudes expressed as $10^{-2}a$

Position of keto group	Sign and amplitude of cotton effect	
	5α-series	5β-series
1	Anomalous*	−136
2	+121	...
3	+65	−27
4	−94	+ 3
6	−76	−77
7	−16	+29
11	+12	
12	+10	
15	+146	
16	−279	
17	+140	
20	+178	

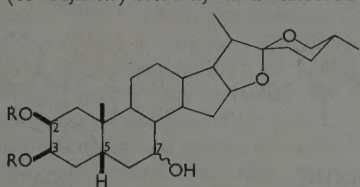
* No apparent Cotton-effect

A good example is provided by the steroid sapogenin, metagenin, which was shown by Takeda *et al.*[17] to be a 2,3,*x*-trihydroxy-compound (III). The triol was converted into a derivative (2,3-diacetoxy-*x*-ketone; IV)



(II) Steroid Numbering

which contained only one carbonyl group in the 'unknown' position *x*. The rotatory dispersion curve[2] of this derivative resembled the reference curve of a 7-oxo-5β (or A,B-*cis*)-steroid, and differed from all



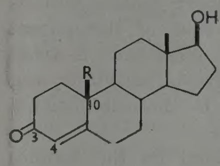
(III) (R = H)
(IV) (R = Ac, and : O at C-7)

others; *x* is therefore 7 and the configuration at 5 is β; these deductions were subsequently confirmed by chemical methods.

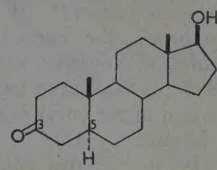
Relative Configurations

Rotatory dispersion analogies are most valuable in dealing with a variety of problems concerning the *relative* stereochemistry of two or more centres in the same molecule. The following are a few of the many examples of this type available.

Analogues of steroids in which the angular methyl group at C-10 is replaced by a hydrogen atom (19-nor steroids; V, R = H) are of considerable importance as synthetic pharmaceutical agents. The close similarity of the rotatory dispersion curves of the natural male hormone testosterone (V, R = Me) and of its 19-nor analogue (V, R = H) indicates[18] that the configuration of the substituent at C-10 (methyl or hydrogen) must

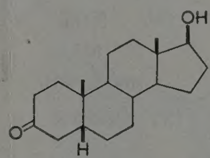


(V)

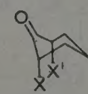


(VI)

be the *same* in both cases. Reduction of compounds of type V can yield 5α (A,B-*trans*) or 5β (A,B-*cis*) compounds (VI and VII) respectively. In the natural steroid series (VI, VII, R = Me) the two compounds



(VII)



(VIII)

X = Cl, Br : Cotton effect +
X′ = Cl, Br : Cotton eflect −

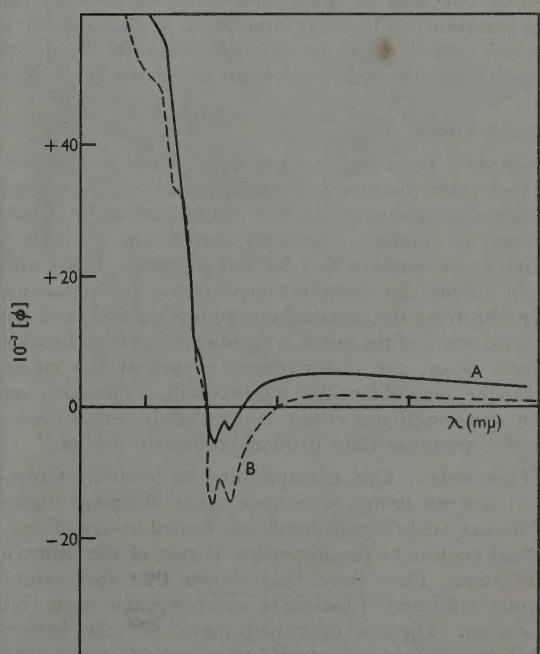
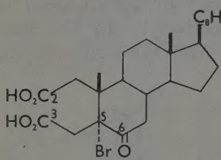


FIG. 4. Cotton-effect curves (complex). To illustrate stereochemical analogy. A, testosterone; B, 19-nortestosterone (solvent, dioxan)
(Based on Djerassi *et al.*,[1] recalculated as molecular rotations)

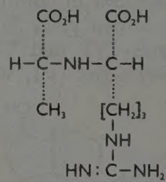
have Cotton-effect curves of different signs (VI, positive, VII, negative, *cf.* Fig. 4). The fact that the predominant isomer formed on reduction in the 19-nor series (R = H) has a positive curve[19] shows that it must be the 5α-19-nor compound (VI, R = H).

Compounds containing α-halogeno-ketone groups (*e.g.* –CO·CHBr–) show very characteristic dispersion curves which are especially valuable in the cyclohexanone series.[20] If the α-halogen substituent is equatorial, the curve resembles that of the parent ketone; if, however, the α-halogen substituent is axial, the dispersion curve has a much greater *amplitude*, and the sign of the curve is determined by the rule depicted in formula (VIII).

The use of this rule is illustrated by the bromoketone (IX); this was obtained from the corresponding



(IX)



(X) Octopine

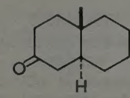
unbrominated ketone and might have its bromine at C-5 or C-7, and in either equatorial (β) or axial (α) configuration. The large amplitude of the dispersion curve[21] showed that the bromine must be axial; its negative sign showed that it must be 5α, *not* 7α.

Absolute Configurations

General. Extensive use has been made in the past of molecular rotation differences (usually ΔM_D values) in the assignment of absolute configurations.[22] Comparison of rotatory dispersion curves now provides a much more sensitive tool for this purpose. Even with plain curves, the dispersion method has the advantage of multiplying the comparisons a hundred-fold, and the general trend of the curve is significant. When Cotton-effects occur, the characteristic shapes of the curves make the method far more sensitive still. Vicinal action and conformational effects will certainly require more careful attention than in monochromatic studies.

Plain curves. One example may be quoted. Greenstein and his group, who have made extensive studies of amino acids,[23] calculated the contributions of individual centres to the dispersion curves of the isomeric octopines. They have thus shown that the natural isomer is formed of D-alanine and L-arginine units (X).

Ketones. Djerassi examined many bicyclic ketones analogous to common steroid types and of known absolute configuration (*e.g.* XI), and found that each gave a Cotton-effect curve of the *same* sign as its steroid analogues. This experience led him to state[19] that 'typical features of dispersion curves of alicyclic *mono*-ketones are on the whole only a reflection of the immediate structural and stereochemical environment



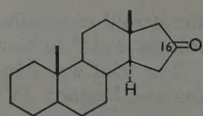
(XI)

around that particular carbonyl group.' Djerassi then extended the generalized method of molecular rotation differences (Klyne[24]) as follows:

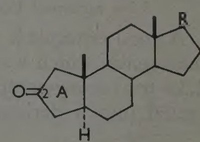
'(*a*) Terminal ring units of the same type make contributions to the rotatory dispersion curve which are, very approximately, independent of the nature of the rest of the molecule.

(*b*) Each terminal unit can exist in two enantiomeric types which have rotatory dispersion contributions of opposite sign.'

An excellent illustration of the second principle is provided by 16-oxo and A-nor-2-oxo-steroids (XIIA,



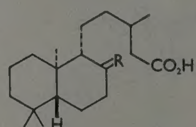
(XIIA)



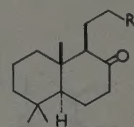
(XIIB)

XIIB), the dispersion curves of which (Fig. 3) are almost exactly mirror-images.

The most dramatic example of the application of these ideas is provided by the diterpene, eperuic acid (King and Jones[25]). This follows the general structural pattern of di- and tri-terpenes, and steroids, but was the first compound of its type to display the 'abnormal' stereochemistry at C-10 (steroid numbering) shown in XIIIA. The dispersion curves[26] of the very similar



(XIII)
(A, R = CH_2; Eperuic acid: B, R = O)

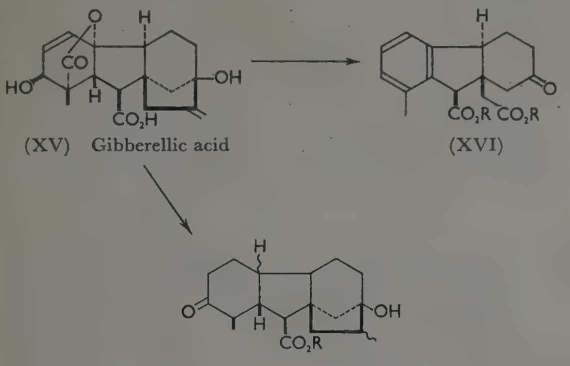


(XIV)
(A, R = CHMe · CH_2 · CO_2H; Ketone from labdanolic acid: B, R = CO_2H; Ketone from manöol)

ketones obtained from eperuic acid on the one hand (XIIIB) and from labdanolic acid[27] and manöol (XIV, A,B) on the other hand were measured. Compound XIIIB shows a positive Cotton-effect curve, whilst XIVA and XIVB (the absolute stereochemistry of the latter is known) show negative curves. These results show clearly that eperuic acid has the 'abnormal' configuration at C-10.

Rotatory dispersion measurements have been used to allot (with certainty or probability) the 'abnormal' or 'antipodal' stereochemistry to a number of other terpenes.

Rotatory dispersion evidence has been used in several different ways in the elucidation of the stereochemistry of the plant-growth substance, gibberellic acid (XV),



(XV) Gibberellic acid (XVI)

(XVII)

by two independent groups (Grove, Stork and their collaborators[28,29]).

Ketones obtained by opening ring D (as XVI) show positive Cotton-effect curves, which, both on simple analogy and on the Octant Rule (*see* opposite), indicate that B : C ring junction has the absolute stereochemistry shown.

Opening of the lactone ring and modification of ring A leads to a ketone (XVII) which has a negative Cotton-effect curve; this is compatible with a $10a\beta,4a\alpha$ or (more probably) a $10a\beta,4a\beta$ configuration. Other chemical and physical evidence (including nuclear magnetic resonance studies) leads to the complete stereochemistry shown in (XV).

CYCLOHEXANONES : A NEW GENERAL APPROACH

A recent theoretical treatment (Moffitt and Moscowitz[30]) relates the optical activity of absorbing compounds to the interactions between the absorbing function and attached atoms and groups. In the more or less rigid cyclohexanone system the geometry of the molecule is well established, and the qualitative application of these theoretical ideas is not too difficult.[31]

Cyclohexanones may be represented by the perspective formula (XVIII). This is divided into eight octants by three planes, *viz.* (A) a vertical plane passing through O, C-1 and C-4; (B) a horizontal plane passing through C-1, C-2R and C-2L (the equatorial substituents attached to C-2R and C-2L are almost but not quite in this plane); and (C) a vertical plane passing through the mid-point of the carbonyl bond and perpendicular to (A). The ring and its substituents, when projected on to a vertical plane to the right of C-4 in (XVIII) are represented in (XIX).

The Octant Rule. In simple cyclohexanone derivatives, all the substituents attached to the ring lie within the four octants far away from the observer's eye in (XVIII), *i.e.* beyond the vertical plane C.

The octant rule for cyclohexanone rotations may be stated for these simple cases as follows :—

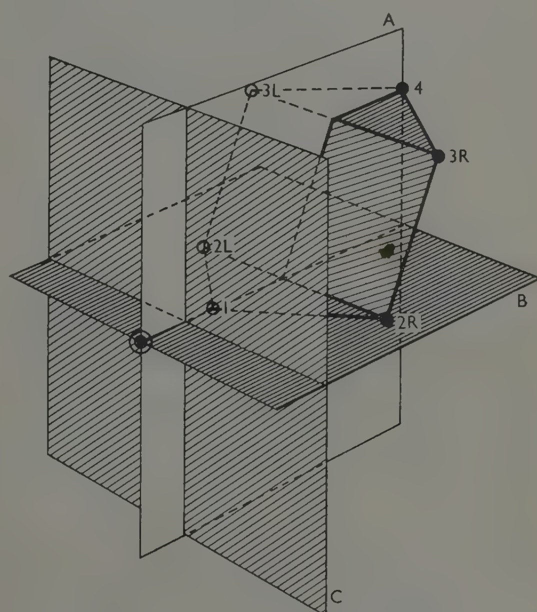
(i) Substituents lying in the *far lower right* and *far upper left* octants make positive contributions to the Cotton-effect;

(ii) Substituents lying in the *far lower left* and *far upper right* octants make a negative contribution to the Cotton-effect;

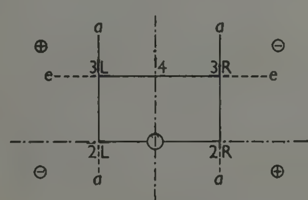
(iii) Substituents lying in any of the planes dividing the octants make *no* contribution to the Cotton-effect.

Group (i)	includes	R2*a*, L3*a*, L3*e*
Group (ii)	,,	L2*a*, R3*a*, R3*e*
Group (iii)	,,	R2*e*, L2*e*, 4*a*, 4*e*

(*a* and *e* indicate axial and equatorial substituents)



(XVIII) Octant Rule



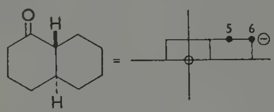
(XIX) Octant Projection

It must be emphasized that the treatment is based on an idealized geometry of the cyclohexanone ring

and necessarily neglects many finer points of detail which are at present obscure.

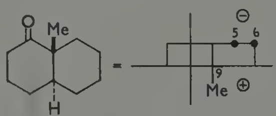
The Octant Rule has been tested[1,3,31] against a large number of ketones studied by Djerassi and his colleagues. With few exceptions the predictions of the rule for compounds whose molecules are simple arrays of cyclohexanone rings agree with the experimental facts—as regards sign, and generally as regards magnitude, of the Cotton-effect. The position with bridged-ring ketones and with cyclopentanones is not yet clear.

An illustration of the value of the Octant Rule is provided by the two *trans*-1-decalones, (XX) and (XXI), which differ only in the presence or absence of the angular methyl group at C-9.



(XX) (XXA)

The non-methylated compound (XX) has a negative Cotton-effect[32] as would be predicted from its Octant diagram (XXA), in which the only atoms making a significant contribution to the Cotton-effect are C-5 and C-6 (both upper right octant; therefore negative). The amplitude is approximately —15 units.



(XXI) (XXIA)

In the methylated analogue (XXI), the angle methyl group makes a large contribution (in lower right octant; therefore positive). Evidence from other sources suggests that the positive effect of this methyl group should outweigh the negative contributions of the two methylene groups (C-5 and C-6)—as in fact it does. The amplitude of the Cotton-effect for (XXI) is +32 units.

PROTEINS AND OTHER COMPOUNDS OF HIGH MOLECULAR WEIGHT: INORGANIC COMPOUNDS

Space does not permit any discussion of the use of rotatory dispersion measurements in these fields. For work on proteins the reader is referred to the review by Blout in Djerassi's book (ref. 1, chap. 17) and work by Moffitt, Doty and Schellman. Increasing use will no doubt be made of dispersion measurements in the study of proteins, polynucleotides and other natural and synthetic polymers made of asymmetrical units.

Applications in inorganic chemistry are chiefly in the field of co-ordination complexes of metals. In addition to classical work there are recent studies by Bailar, Kirschner and Woldbye.

Optical rotatory dispersion measurements can now be carried out as a routine operation; improved instruments will doubtless soon be available. Optical rotation is a property which is almost uniquely valuable in distinguishing between 'right-handed' and 'left-handed' structures of all kinds, whether small molecules or polymers. Its most important application may therefore be in studies of absolute configurations.

The examples discussed in this short review are nearly all ketones, many from the important group of alicyclic compounds, which includes steroids and terpenes; however, the value of the technique is not restricted to this and related fields, though, of course, it can only be useful in dealing with asymmetric compounds.

Optical rotatory dispersion will not be as important in chemistry as infra-red spectroscopy; but even if it has only 5 per cent of the importance of this latter technique, it is well worthy of attention.

REFERENCES

1. Djerassi, C., *Optical Rotatory Dispersion: Application to Organic Chemistry*. New York: McGraw Hill Book Co. Inc, 1959.
2. *Idem, Rec. chem. Progr.*, 1959, **20**, 101.
3. Klyne, W., in *Newer Methods of Organic Chemistry*, Volume I. Edited by R. A. Raphael. New York: Interscience Publishers Inc., 1960.
4. Klyne, W., and Parker, A. C., in *Physical Methods of Organic Chemistry*, Third edition. Edited by A. Weissberger. New York: Interscience Publishers, Inc., 1960.
5. Rudolph, H. C., *J. opt. Soc. Amer.*, 1955, **45**, 50.
5a. Rudolph, H., and Bruce, R., *J. opt. Soc. Amer.*, 1959, **49**, 1127.
6. Gillham, E. J., *J. sci. Instrum.*, 1957, **34**, 435.
7. Gates, J. W., *Chem. & Ind.*, 1958, 90.
8. Grosjean, M., Lacam, A., and Legrand, M., *Bull. Soc. chim. Fr.*, 1959, in press.
9. Bürer, T., Kohler, M., and Günthard, H. H., *Helv. chim. acta*, 1958, **41**, 2216.
10. Fordyce, W. B., Green, J., and Parker, A. C., *Biochem. J.*, 1958, **68**, 33*P*.
11. Savitsky, A., Slavin, W., and Salinger, R. E., *Pittsburgh Conference on Analytical Chemistry and Applied Spectroscopy*, 3 March, 1959.
12. Woldbye, F., *Acta chem. scand.*, in press.
13. Lowry, T. M., *Optical Rotatory Power*. London: Longman Green Ltd, 1935; Kuhn, W., *Ann. Rev. Phys. Chem.*, 1958, **9**, 417.
14. Sjöberg, B., Fredga, A., and Djerassi, C., *J. Amer. chem. Soc.*, 1959, **81**, 5002.
15. Djerassi, C., and Klyne, W., *Proc. chem. Soc.*, 1957, 55.
16. Clark, V. M. *et al.*, *J. chem. Soc.*, 1958, 3283.
17. Takeda, K. *et al.*, *J. Pharm. Soc., Japan*, 1957, **77**, 175.
18. Djerassi, C., Riniker, R., and Riniker, B., *J. Amer. chem. Soc.*, 1956, **78**, 6362.
19. Djerassi, C., and Closson, W., *ibid.*, 3761.
20. Djerassi, C. *et al.*, *ibid.*, 1957, **79**, 1506; 1958, **80**, 1216.
21. Summers, G. H. R., and Klyne, W., unpublished.
22. Klyne, W., in *Determination of Organic Structures by Physical Methods*. Edited by E. A. Braude and F. C. Nachod. New York: Academic Press, Inc., 1955.
23. Greenstein, J. P. *et al.*, *J. Amer. chem. Soc.*, 1955, **77**, 3112; 1957, **79**, 652.
24. Klyne, W., *J. chem. Soc.*, 1952, 2916; 1953, 3072.
25. King, F. E., and Jones, G., *ibid.*, 1955, 658.
26. Djerassi, C., and Marshall, D., *Tetrahedron*, 1957, **1**, 238.
27. Cocker, J. D., and Halsall, T. G., *J. chem. Soc.*, 1956, 4262; 1957, 4401.
28. Cross, B. E., *et al.*, *Chem. & Ind.*, 1959, 1345.
29. Stork, G., and Newman, H., *J. Amer. chem. Soc.*, 1959, **81**, in press.
30. Moffitt, W., and Moscowitz, A., *J. chem. Phys.*, 1959, **30**, 648.
31. Moffitt, W. *et al.* In preparation; for fuller summaries, see refs. 1 and 3.
32. Prelog, V. Unpublished; the author is indebted to Prof. Prelog for this important example.

THE EDUCATION OF CHEMISTS

By T. L. Cottrell, D.SC.*

Professor of Chemistry, University of Edinburgh

In my career so far I have had much more to do with chemists themselves than with their formal education. My views therefore have not yet had to stand the test of practical teaching experience, and it is possible that events may force me to modify them.

My lack of teaching experience, however, would seem more serious to me if there were a body of reliably established information about the effects of different kinds of education on the achievements of scientists. But so far as I can see from the literature, this does not exist. So-called experiments in chemical education are usually not experiments at all: they are simply changes of teaching method or material, without any rigorous attempt to follow up the results of the change. This means that most of the existing knowledge about the education of chemists is at the anecdotal level. And, *a priori*, my anecdotes may be as good as those of anyone else. They may also be different, because I have had more experience of working with, for and in charge of the average chemistry graduate—who does not remain in the academic world—than many of my colleagues who have devoted their whole careers to academic chemistry. I must use my experience while it is still fresh in my mind, and this is the main reason for my choice of topic for this lecture.

To use this experience for my present purpose, however, I must firstly consider some fundamentals. I must ask what a university is for, before I can discuss how it is to do its job. It will, I imagine, be readily agreed that a university is concerned with the discovery and dissemination of certain kinds of knowledge, and also with the preservation and inculcation of certain attitudes to knowledge—attitudes usually described as 'academic' and 'intellectual.'

Let me take an illustration from a different field of study. A knowledge of the prices on the London stock exchange today is not of itself suitable for consideration by members of a university in their official capacity, however important it may be to some of them in their private lives. On the other hand, the trend in London stock exchange prices in 1959, compared with those in New York in 1929, might be the legitimate academic concern of a social scientist or an economist. And if this comparison enables some socially useful or even profitable action to be taken by somebody, the knowledge is in no way the less suited to university study. The point is that particular instances are studied, not for their own sake, or for the sake of profit, but for their part in promoting a general systematization of experience.

Similarly the fact that by carefully following the instructions on page 395 of Cumming and Kay's textbook it is possible to determine the amount of manganese dioxide in pyrolusite, is *by itself* of no interest to a member of the university, however important it may be to those unfortunate few—who are very unlikely to be university graduates—who make their living by carrying out this analysis. This knowledge is only of academic importance in so far as it can be related to systematic chemical theory. The point was put very bluntly by one of the greatest of all Scottish chemists, Archibald Scott Couper, the first man to devise the structural formulae of organic chemistry. The paper in which he described his discovery begins simply: 'The end of chemistry is its theory.' This, to my mind, is a correct definition of the end of academic knowledge of chemistry.

But theories may or may not be useful in the day-to-day life of the community. Academic knowledge is in this respect mixed: some of it is directly applicable in society, some of it has no obvious direct application. The emphasis on the different components of this mixture is constantly changing. For example, in the eighteenth century, when science was taught at only a few universities, it was the proud claim of many professors of chemistry that what they taught was valuable to 'manufacture and the useful arts.' About 30 or 40 years ago, on the other hand, it was fashionable in some academic circles—although I think not in Edinburgh—to claim that academic knowledge was practically useless, and to thank heaven that this was so.

This latter attitude would be a hypocritical one for us to take up today when more than two-thirds of the income of the universities comes directly from the state. We may take it, then, that university knowledge has to be judged from two points of view: it has to be judged by its conformity with traditional university studies and by its internal consistency, that is, by its academic quality, on the one hand, and by its relevance to the current situation in society at large on the other hand. If the traditional interests of a university become too inflexibly established, then the influence of universities on the progress of human thought and of society will diminish. If, on the other hand, the university's assessment of the value of knowledge becomes simply identical with that of society, the university will have lost its right to be considered as a distinctive feature of the intellectual life of society, and will become indistinguishable from a training college.

If, then, we must concern ourselves with what society is doing, it behoves us, in considering the university education of chemists, to consider what chemistry

* Based on Professor Cottrell's Inaugural Lecture delivered to the University on 20 November, 1959.

graduates do. It does not follow that we should then set out to train new chemists to do exactly what older chemists are doing at present; but it should lead us to enquire whether the distinctive intellectual characteristics of the university graduate are particularly relevant to the professional work of the chemist, and if so, whether we do sufficient to help him to acquire them.

Unfortunately, we cannot answer the question, 'what do chemists do?' in any sound statistical way, but we can answer the more trivial question of, 'who pays the chemistry graduates their salaries?' There were in 1956 some 21,000 qualified chemists in Great Britain, of whom about 13,000, or 64 per cent, were employed in industry. About 8 per cent were employed directly by the government, about 24 per cent were employed in education in schools and technical colleges, and about 3½ per cent in universities. What is taught in schools is largely determined, though with some time lag, by what is taught in universities, and what is taught in technical colleges is determined partly in the same way and partly by industrial requirements. Accordingly, we can for the present purpose leave out of account the activities of the 24 per cent in general education. The 8 per cent employed by the government are mainly doing research and development similar to that done in industry, so that we can say that there are roughly some 72 per cent of chemists engaged in applied chemistry, 4 per cent in academic teaching and research, and the activities of the remainder are largely determined by what these two groups do.

When we leave the question of who pays the chemist and ask what he does, we leave the ground of firm statistics. There is some evidence that a little more than half the applied chemists are engaged in research and development, and the remainder on production, selling, sales service and general management. Firms and industries differ in the extent to which scientists penetrate to general management. No one who, like myself, has had the stimulating experience of working for Sir Ewart Smith, until recently deputy chairman of Imperial Chemical Industries Ltd, could fail to be impressed by the importance of educating scientists and engineers for general management, and it is tempting to correlate the vigour of the British chemical industry since the war with the extent to which its management has been in scientific hands. It is also tempting to correlate the decline of much of the British chemical industry in the latter half of the nineteenth century with the subordinate position which its all-too-few chemists tended to have. I do not, however, propose to include this aspect of the activities of chemists in my discussion for two reasons. Firstly, the majority of chemistry graduates in industry are not in higher management, and secondly, the changes which I believe to be desirable in the education of chemists from the point of view of their activities as chemists would also be helpful in improving their potentialities as managers.

We concern ourselves then with a number of chemists engaged in a variety of activities, the most usual of which are research and development. We know, moreover, that, in 1955, 80 per cent of all research and development personnel—that is, qualified scientists and engineers—were employed in establishments whose research and development staff numbered more than 50. There were comparatively few such establishments: only 309 in the whole of manufacturing industry. This means that most chemists carry out their work in conditions in which there is a fair amount of specialization. Further, we know that in the chemical industry there was on the average a supporting staff of 1½ persons for every chemist employed. At a guess, of these 1½ persons, one was a laboratory assistant either with or in the process of obtaining a technical qualification, and the half included clerical and other ancillary workers. Much of the experimentation in chemical research and development is carried out on a larger scale than in the conventional laboratory, and such conventional laboratory work as is necessary to support it is usually done by technicians. We have the picture, then, of the average chemistry graduate engaged in research and development, not necessarily on the laboratory scale, with skilled help to carry out much of the manipulative work and with specialist services, such as analysis, provided.

We may ask then what the research and development chemist is expected to do. He is expected to see that the chemical knowledge relevant to the purposes of the organization is correctly applied and to provide new chemical knowledge with the same relevance. He can do this by having a critical knowledge of the field and by applying this knowledge, by designing experiments to supplement it where necessary, by analysing the significance of this knowledge and by suitably presenting the results of the analysis to the other members of the organization.

When we move from the question of what chemists do to how well they do it, and whether they could do it better if their education had been different, we leave the ground of even vague statistics and enter the realm of personal impressions. But it is just my personal impression, my anecdotal knowledge, of the professional performance of chemists in industry which is central to my views on the education of chemists, and to record which is the chief object of my lecture.

My main personal impression is that the most striking characteristic of the chemist in industry is his lack of professional competence. People often complain about the lack of liberal interests of scientists and their difficulty in dealing with people; some industrialists have said they lack leadership. I do not know whether these complaints are true, nor do I see what the universities could or should do about them. The fact that it has been for some time fashionable to send the young of the English governing class to Oxford and Cambridge has given some industrialists the idea that all universities

ought to be training grounds for leadership, and they have criticized other universities because they are not. In fact universities are places for the education of scholars and professional men, and the connection of Oxford and Cambridge with leadership is an accident of fashion. *My* complaint is a much more serious one : it is that a high proportion of honours university graduates in chemistry are not very good chemists and that their deficiency could be at least partly remedied by improving their education.

Let me be more specific about the respects in which I believe the chemist is less competent than he might be. The first is that when faced with a problem of a type he has not met before, he resorts to the purest empiricism, untinged by chemical theory. It is as if he had decided that the chemical theory he had spent four years in acquiring was all very well in the lecture room, but of no use in the serious practical world of chemical industry. For him an education in chemical theory is equivalent to the education in Latin that the chemist attending some universities in England must have undergone—something to be endured for the sake of getting a degree and to be forgotten as soon as the paper qualification is achieved. There are chemists for whom the height of theoretical sophistication is to calculate a yield as a percentage from the stoichiometric equations.

A type of industrial problem that is frequently encountered is one in which the effect to be investigated is influenced by a fairly large number of variables and is not obviously covered by a well-established and familiar theory. The industrial chemist under these conditions often reduces scientific method to the bare essential of holding constant all the variables except one, and measuring the dependence of the effect on each variable in turn. The result is a forest of graphs, from which it is often almost impossible to deduce anything useful. The next stage in scientific sophistication is reached when all the variables are changed at once, and correlation coefficients are calculated in the hope of extracting something useful from the mess. This at least has the merit of being cheaper than the former process, but is not likely to provide any more insight into the effect being investigated. Such methods of investigation have their place when the effect is one about which nothing at all is known, but chemistry is a sufficiently well-developed science for this to be rare. It is usually possible to form a reasonable hypothesis about a process and deduce from it what are the significant variables.

The next and perhaps even more important defect, of which I must admit to having been guilty myself, is an insufficiently critical and enquiring attitude to the research problem. Vast amounts of money are poured down the drain in the investigation of problems which do not require solution. A simple example is the following. The chemist who is responsible for the chemical side of a process is asked by the engineer, who is concerned with providing the cooling, to tell him the specific heat of the reaction mixture. This is not known, and the chemist concerned asks his colleague responsible for making physical measurements to measure the specific heat of a mixture of A and B. This is done, and the answer given to the engineer. But it is probable that the engineer only wanted it to within let us say 25 per cent, and the first chemist might have known that the specific heats of chemically similar liquids rarely differ nearly as much as this from one another. He might, therefore, have looked up a few figures and given the engineer a value that would have been adequate for his purposes. Or the second chemist might have asked how accurately it had to be known. In either case much money would have been saved. Here certainly the ability to ask the right simple question is vastly more important than the ability to carry out the determination correct to, say, ± 1 per cent.

Related to this there is an even more depressing failing : a tendency to do experimental work rather than look up the literature. It is not sufficiently realized that experimentation is a time-consuming and expensive business, which should be resorted to only if it is certain that the result is needed and that it is not already known. One might say that if the chemist who can make a measurement (or carry out an analysis) accurately is worth his weight in lead, and the chemist who can improve the method is worth his weight in silver, the chemist who can show that the measurement is not necessary at all is worth his weight in gold. I should perhaps add, in case there is any misunderstanding, that this argument does not apply to speculative work in a new field of chemistry, where it cannot be said whether the result will be important until it is obtained.

The third defect is so frequently discussed that it is almost a platitude to mention it : most chemists can't write. The editors of scientific journals bewail the fact frequently. It is admitted by all, but I doubt whether its seriousness is sufficiently appreciated. It is usual for those who administer research to be able to write a tolerable report on their work; this is one of the characteristics for which men are chosen to administer research. The time they then have to spend fighting with the appalling form in which their highly qualified staff usually describe their researches often detracts seriously from the attention they can give to the content of the work. What is particularly maddening about this defect is that there is no excuse for its persistence.

These three common defects—the lack of power to apply theory, the lack of a critical approach to the problem in hand and the inability to communicate clearly—are all aspects of the same thing : the lack of an academic approach. The academic approach to knowledge is critical and theoretical, and essentially concerned with its communication, and these are qualities in which I suggest chemists are deficient. This deficiency has adverse practical consequences. If I am right we arrive at the apparently paradoxical conclusion that

the greatest *practical* defect of the professional chemist is a lack of *academic* intellectual qualities.

Stated thus, my position, I am sure, would not commend itself to many of my former colleagues in industry. On the contrary, they comment that newly graduated chemists are too theoretically inclined: I think that their views are valid but their terminology is wrong. The newly graduated chemist does have his head stuffed full of a selection of facts and theories which happen to be fashionable in academic circles at the time—but this is the natural result of the present course, success in which does not guarantee the important academic intellectual qualities which I have just enumerated: an interest in theory, a critical intellectual approach and an ability to communicate.

If in fact most chemistry graduates were already too academically minded, instead of being, as I suggest, insufficiently so, there would be queues of applicants of high quality from all universities for academic jobs in chemistry. This is simply not so. All the Scottish universities and almost all the English provincial universities are net importers of chemistry teachers. In 1957, only five Edinburgh chemistry graduates were lecturers or professors in chemistry departments in other universities. Similar figures hold for Aberdeen and St Andrews, although Glasgow is more nearly in balance. The balance is mainly supplied by Oxford and Cambridge. This means that the average chemist—not from the senior English universities—is either not academically inclined or not academically acceptable.

If I am right we must enquire whether this is a consequence of an attitude which already exists in the intake to the universities, or a consequence of the type of education received at them. I now restrict my attention to the Scottish universities, in particular to Edinburgh, because I am not sufficiently familiar with the English provincial universities to be able to draw them into the discussion. As far as the Scottish attitudes are concerned, there seem to me to be two opposing factors: the traditionally high social prestige of the universities on the one hand, in particular the apotheosis of the university professor in Glasgow and Edinburgh in the nineteenth century, traces of which can still be detected, and, on the other hand, the distaste of the Scot for 'high flown' ideas, except perhaps in the field of religion. Even in Edinburgh in the eighteenth century, Hume the philosopher was largely ignored, but Hume the historian was praised. The preference of the University of Edinburgh for P. G. Tait over James Clerk Maxwell for the Chair of Natural Philosophy in 1860 is perhaps an illustration of this tendency. One has the situation that the office of professor is highly regarded, while the claims of the practical man are met by the tendency to elect intellectually down-to-earth persons to the office. It is possible, therefore, that there is a socially determined anti-academic, though pro-university, attitude in entrants to Scottish universities.

Granted then that we, as academics, meet certain anti-academic prejudices in our relationship with our students, we must ask whether we do nearly enough to overcome them. Even more to the point, we must ask whether the chemistry degree course is one in which these academic intellectual virtues are fostered or at least given the opportunity to develop.

My impression is that the chemistry course at present tends not to do this. The student spends most of his time in laboratory exercises and, in addition to this, has to memorize a large amount of information for reproduction in examinations. Since the laboratory course consists largely of experiments (they are called experiments but they are really manipulative exercises) in which the method of working out the result is directly prescribed, he has little experience in the understanding or application, as distinct from the memorizing, of chemical theory. Since the amount of material he has to reproduce in his examinations is large, he has time only to read one account of each topic, and thus misses the opportunity—so fruitful in developing a critical approach—of comparing two different ways of going about the same problem. Wide or deep reading in chemistry is only attempted by the exceptional student.

There is, I believe, a growing opinion within the University that the student does not have sufficient opportunity to read and to think for himself, and that a remedy for this must be sought. My criticism is thus not novel. Perhaps, however, my reinforcing an already-existing tendency may help towards the achievement of some change.

My main suggestion to allow time for thought is simply that there should be a drastic reduction in the time spent in laboratory work in the chemistry course, and a reduction, not perhaps quite so great but nevertheless significant, in the amount of the time of the student which is organized and supervised.

To consider the justification for this suggestion we must examine the function of manipulative work in the education of the chemist. It is said to be twofold: firstly as education and secondly as training. Let us take, for example, the manipulative operation of titrating a base with an acid. The educative argument in favour of doing this runs: among the classes of compounds with which chemistry deals there are acids and bases; their mutual interaction cannot be properly appreciated unless it is observed personally. The training argument is: chemists titrate acids with bases; the student is going to become a chemist; therefore he must be able to titrate acids with bases.

Firstly, we must dispose of the training argument, which is unsound. The simple and fatal objection to the training argument is that most chemists do not do titrations. Such operations, which are basically simple but which require some manipulative skill, are most economically carried out by people trained to do this job only. Operatives quite ignorant of chemistry can,

and in fact do, carry out routine chemical operations with the highest accuracy. Moreover, even with the training he now gets, the chemist faced with a job of this kind will usually have to practise it for a little before he can do it satisfactorily. He will in fact have to learn to do it again. There certainly are parts of chemical research where manipulative skill of a very high order is required of the chemist himself, but this skill is usually too specific for it to be worth while training all chemists for it in an undergraduate course. I should add here that although the student spends a large number of hours a week in the laboratory, there are still many important experimental skills, such as wiring-up electronic circuits and glass-blowing, which he does not acquire. These come later, and nobody worries very much about this, because they are not traditional skills of the chemist. It is possible, however, that more graduate chemists have to wire up circuits than ever have to do gravimetric analysis. We conclude, therefore, that the training function of manipulative work is only admissible in a university to a very limited extent. It cannot easily be completely abandoned, because the outside world expects graduate chemists to have acquired some basic manipulative techniques, and in any case some sort of skill is required for the student to appreciate the educational function of laboratory work. It seems likely that a basic minimum technique could be built up in very much less time than is at present devoted to laboratory work. Before leaving this point, we may in passing draw a corollary from it—that purely manipulative skill should have relatively little effect on our rating of a student as a potential chemist.

The educational argument in favour of manipulative work is undoubtedly valid up to a point. Chemistry is an experimental science, and some parts of it are still largely descriptive. The nature of the experimental methods by which the facts of chemistry are observed can, it is said, and reasonably enough, best be appreciated by the student if he repeats the experiments for himself. However, even in the present four-year course, only a very limited proportion of the experiments that first elicited the facts now supposed to be known can be carried out by the student. Every chemistry student, for example, knows about the separation and detection of isotopes in the mass spectrograph, an experiment of fundamental importance, yet very few students indeed have handled a mass spectrograph, nor would it be feasible to allow them to do so. We have this state of affairs—that many of the fundamental experiments are not carried out by the student (although he probably understands them well enough), because of both time and expense. It follows that the actual manipulative work, after the most elementary level, is an arbitrary selection from a much wider range of possible exercises. I strongly suspect that the number of exercises at present carried out is determined by the traditional length of term, the traditional length of time for an honours degree not involving manipulative work—four years—and the length of the working day, and does not derive from a consideration of the basic minimum amount of manipulative exercises necessary to illustrate chemistry. If it does, then it is a truly remarkable fact that it takes four years exactly. If it is arbitrary, it can take an arbitrary reduction without much trouble.

One should be the more prepared to tolerate such a reduction after examining some evidence recently obtained by Professor Weatherall at the London Hospital leading to the conclusion that laboratory teaching appears to be the least efficient method of bringing home elementary facts in pharmacology to medical students. I recommend his remarks to believers in the method.

I suggest that a reduction to half its present amount seems reasonable—but this is arbitrary and the best figure might turn out to be something different. A synthetic approach to the basic minimum should be made, rather than an attempt simply to cut the existing course by a given fraction. At the same time we should try to avoid wasting laboratory time by using inefficient apparatus. Weighing by counting the swings of the traditional balance, for example, might be mentioned in a lecture for the benefit of those few students who will be unfortunate enough to enter an establishment which thinks it cannot afford modern equipment. But the student should not have to suffer the tedium of counting swings in practice. Of course, if the less efficient device exemplifies a theoretical point which its more efficient successor makes obscure, then the former must be used. But we must beware the tendency to believe that each generation must first follow in detail the errors of its forefathers before it is allowed to share in advances of the present. In science, and in any other branch of learning which is genuinely progressive, what was good enough for us is emphatically not good enough for our successors. If it were, we should have failed in our job.

The discipline of formulating the minimum amount of knowledge a graduate should have might well be applied in the field of lecture instruction as well as of laboratory instruction. I will not develop this idea further than to say that if we did so we might be able to ensure that this minimum was properly understood. I very much doubt whether all the information students at present acquire is anything like understood.

We are responsible for organizing a proportion of our students' time so that they can achieve as satisfactory an academic introduction to chemistry as is possible in four years. I have suggested that, largely because of the present emphasis on manipulative exercises, they have inadequate opportunity to understand chemical theory, to read and think critically or even creatively, or to practice the communication of what they know. We have, I hope, agreed that the manipulative work could be drastically reduced, let us say, to half its amount. What are we going to do with the remaining time to help to inculcate the academic attitude that we consider desirable?

In the first place we must beware the temptation to fill the freed time completely with formal exercises of a different kind. I have found discussion with my colleagues one of the most effective ways of clarifying my ideas on any subject. It is to be hoped that some of the freed time would be filled by the students with discussions among themselves. The better would almost certainly do so : the less interested probably learn nothing from manipulative work anyway, so even if they did not join in discussions it is unlikely that there would be a net loss. But there are two things we can ask students to do, each of which might help progress in the wished-for direction.

Grasp of the application of theory can best be achieved by trying to apply it. Practice in its application can be gained by doing calculations. So I suggest the replacement of some practical manipulative exercises by practical exercises in calculation. Care would need to be taken to avoid their becoming as much a formality as the manipulative work, but this could be done, since the economically possible range of chemistry on paper is infinitely greater than the economically possible range of laboratory chemistry.

Critical thought and reading could, I hope, be fostered by asking students to write essays on suitable topics, and then to discuss their essays, the tutorial discussion being as important as the essays. It is a standard method of instruction in the faculty of arts, and it is the lack of this method in science that is chiefly responsible for the indifferent level of skill in writing attained by many chemists.

It has been suggested that the rapid advance of scientific knowledge has made it necessary for a chemist to acquire so much scientific information, if he is to become well-educated, that there can be no time in the undergraduate course for calm reflection and for such frills as writing essays. I think that this argument must be met in two ways. Firstly we must recognize that scientific advances may, by including more facts in the scope of a wider generalization, reduce rather than increase the amount of information to be memorized. We must take full advantage of this when it happens, although I must admit it happens all too seldom in chemistry. The Bohr atom and the van der Waals equation are the only pieces of chemistry which come immediately to mind as intellectual lumber which could be relegated to the attic of the history of science. Secondly we must remember that if we are concerned to cram the honours student with the latest in chemistry we must recognize that this, too, will be superseded in a short while. We must give him a firm grasp of fundamental theory into which he will be able to fit the new information as he acquires it; we must give him the critical and analytical approach that will enable him to gauge its significance; and we must give him the opportunity to achieve for himself the interest in chemistry that will prompt him to seek it for himself. In short, the honours student can not be expected to know it all, so there is no point in trying to cram him as full as possible.

It seems likely, too, that these desirable effects may be fostered by allowing the chemist, after a fairly elementary course of laboratory manipulation, to engage in a research problem of his own. This should encourage application of theory, because the research will not otherwise be comprehensible, and it should encourage a critical approach, because the student will be unwilling to waste his time by carrying out experiments that will not lead to the end in view. The research must, however, be carefully chosen, otherwise the student may become a simple technician for his research supervisor. The best way of avoiding this—and when it has been adopted I shall know the millennium has arrived—would be to provide university staffs with real technicians on an adequate scale, to remove the temptation to use their students as such. But I must be realistic.

In most of my lecture, I have been concerned with what I consider to be the defects of the average chemistry graduate. I am aware that this has consequently been a one-sided account, yet one that I thought should be given because the other side is so often stressed. The achievements of the chemical industry proclaim the virtues of the average chemist to the world, and I need not elaborate on them here.

You will also note that I have said nothing about chemical discoveries. For great scientific achievements the academic intellectual virtues are no longer sufficient, and creative genius is required. I have not discussed genius, because I have no idea how to produce it by formal education. We must legislate for the majority, and hope that we shall be able to recognize and encourage great creative powers when we encounter them.

In concluding, I should emphasize a point made at the beginning of this lecture : my views are tentative rather than firm. I have said that I have learned much from discussion with my colleagues in the past : I still hope to learn much from discussion with my colleagues, both university teachers and students, in the future. My present view of the best method of organizing the education of chemists is, for me, rather the opening of a debate than a direct guide to administrative action. On one point only am I not prepared to shift my position. It is my assertion that we, as academics, have a duty to society to be academic. We are supported on a scale which is only justifiable if the academic attitude has a valuable contribution to make to society. I believe that it has, and that the academic attitude, with its insistence on theory, and its critical and intellectual approach, is distinctive and important. That I now have the opportunity of trying to further it is one of the chief reasons why I am particularly proud to occupy a Chair founded in a century when Scotland led the world in appreciation of the value of the interaction between academic and industrial chemistry.

Book Reviews

ANTIBIOTICS: THEIR CHEMISTRY AND NON-MEDICAL USES. H. S. Goldberg. Pp. x + 608. *New York: D. Van Nostrand Co. Inc.*; *London: D. Van Nostrand Co. Ltd*, 1959. 112*s*. 6*d*.

According to figures quoted in the introduction to this book, more than 20 per cent of the antibiotic production of the U.S.A. in 1954 was absorbed by the feeding-stuffs industry as supplements to animal rations. Since then, antibiotics have become of increasing importance in other branches of industry as well; hence the timely publication of this comprehensive account of the non-medical uses of antibiotics. The book covers the uses of antibiotics, both current and potential, in animal nutrition, control of plant diseases, food preservation and cultivation of micro-organisms.

In the introductory chapter such topics as the occurrence, economic importance and modes of action of antibiotics are discussed and, although the treatment of each is necessarily brief, an adequate list of references is given for those who wish to delve more deeply into these subjects. There follows an excellent account of the chemical structure and properties of antibiotics. As nisin is becoming of increasing interest in Europe in canning and cheese-making processes, its omission from this chapter is unfortunate. However, the chemical characteristics of all the more common antibiotics are very thoroughly presented and several of the newer and less widely known are also included.

The addition of antibiotics to animal feeds and the improvement in growth rate that usually results have aroused great interest in recent years, and the subject is treated fully in this book. It must be remembered, however, that many of the statements regarding current feeding practice refer only to the U.S.A., since legislation in many other parts of the world forbids the addition of antibiotics to feeds except in certain defined circumstances. The possible modes of action by which antibiotics stimulate growth are set out in some detail, although several of the proposed hypotheses must still be regarded as speculative.

With the increasing importance of antibacterial and and antifungal antibiotics in horticulture, a chapter on their influence on plants and plant disease control is welcome. The more practical aspects of the subject such as methods of application and persistence in the soil are dealt with, as well as fundamental problems of absorption by, and movement through, plant tissues.

Antibiotics have not yet been universally adopted as aids to food preservation, since the possible dangers to the consumer have still to be fully explored. Their potential importance in reducing the present high losses of foodstuffs due to microbiological spoilage is pointed out, and there is a clear account of present knowledge on the use of antibiotics in conjunction with refrigeration, in the canning industry and in the preservation of quality of all classes of fresh foods.

Microbiologists will find valuable the chapter on the isolation and cultivation of micro-organisms with media containing antibiotics. In the final chapter the significance for public health of these widespread non-medical uses of antibiotics is discussed. This is a balanced statement on a somewhat controversial topic.

The book is well presented, although some sections occasionally show evidence of careless proof-reading and the index is not quite complete. The bibliography is extensive and, as each entry is accompanied by a short précis, will provide a convenient and rapid source of reference.

M. E. Coates

BIBLIOGRAPHY OF CANCER PRODUCED BY PURE CHEMICAL COMPOUNDS. O. Neubauer. Pp. xxvii + 604. *Clarendon Press: Oxford University Press*, 1959. 42*s*.

The preparation of this valuable bibliography was undertaken by Professor Otto Neubauer at the suggestion of the late Sir Ernest Kennaway, who contributed a foreword, and with the support of the Donner Foundation and the British Empire Cancer Campaign. A survey has been made of the whole literature on the production of malignant tumours by pure chemicals of known structure up to and including 1947.

An author index which lists alphabetically each paper with full title and, where necessary, a brief explanatory note on the contents occupies the first 270 pages, and a subject index and a list of tumour sites and special kinds of tumour completes the work. The subject index is divided into 32 sections which deal with such topics as chemical and physical properties of carcinogens, local and distant carcinogenic effects, metabolism and chemical constitution of induced tumours, production of mutations, the induction and treatment of leukaemia, and the fate of carcinogens in the organism. In the various sections subdivision is made according to the nature of the carcinogen, the main groups being polycyclic hydrocarbons, azo-compounds, aromatic amines, and lipoids (including steroids). There is a separate section on sex hormones which includes steroid hormones and hormones of the anterior pituitary and the epiphysis.

The effects of arsenic (because of an earlier comprehensive review), colchicine, and mustard gas have not been included, the last two not being considered to be carcinogenic. Any future compilation must include work on the so-called biological alkylating agents, of which mustard gas is a member, since in this group of compounds numerous 'nitrogen mustard gas' derivatives, epoxides, ethyleneimines, and methanesulphonates have now been shown to have undoubted cancer-producing properties. One can go further and say with Walpole (*Ann. N.Y. Acad. Sci.*, 1958, **68**, 750)

that 'the carcinogenic potentiality of alkylating agents is not merely an academic question, but a matter of immediate practical concern.' The well-defined chemical reactivity of these agents may well indicate the mechanism by which the malignant transformation occurs. Drawing attention to this omission is not to be regarded as a criticism of the present work, since most of the developments in this field have taken place since 1947, but rather as an indication of what should be included when the next edition is prepared.

This bibliography will be of great value to all engaged in cancer research. It is very well produced and is of moderate price considering the effort which has gone into its compilation: the cost works out at about twenty detailed references for one penny!

W. C. J. ROSS

CRYSTAL GROWTH. (Discussions of the Faraday Society No. 5, 1949.) Pp. 366. *London: Butterworths Scientific Publications*, 1959. 60*s*.

This general discussion of the Faraday Society was first published in 1949. It is still of great interest, not only for its value as a reference work on crystal growth topics but also as a classic example of the value of Faraday Society Discussions in bringing together theoreticians and experimentalists in a given field. At the time when this discussion took place experimental work on crystal growth had not yet taken full cognizance of new developments in crystal-growth theory, and the discussion served a most useful function in focusing attention on them. Indeed it is doubtful whether the considerable activity in this field in the past decade would have occurred in its absence.

Four main topics are considered: the theory of crystal growth (8 papers), nucleation and normal growth (14 papers), abnormal and modified crystal growth (10 papers) and mineral synthesis and technical aspects (13 papers). A report of the discussion which took place on each of these topics is included. Papers by N. F. Mott, N. E. Gardner, A. R. Ubbelohde, I. N. Stranski, F. C. Frank, C. W. Bunn, C. W. Davies, F. Seitz, R. Becker, and D. C. Stockbarger are included among contributions from 47 authors. Many of the papers have now become classic and, if one may particularize, then F. C. Frank's paper on 'The influence of dislocations on crystal growth' and I. N. Stranski's paper on 'The form of equilibrium of crystals' are especially noteworthy.

On the whole the papers describing the results of experimental investigations show the passage of time much more than do the theoretical papers. This is partly the consequence of the intense experimental activity which followed this discussion. Here too, however, many of the contributions are of great interest, notably those by C. W. Bunn, C. W. Davies and S. P. F. Humphreys-Owen.

The original publication of this Discussion by the Faraday Society has long been out of print and the present publishers are performing a very worth-while service in making this volume available once again. The volume has been reproduced without change of pagination. The improved quality of paper and the more serviceable binding will be welcomed by those who find that their original copy has deteriorated with the years of use. In this particular case my recommendation can only endorse the established reputation which has made this reprint necessary.

I. M. DAWSON

PROPERTY MEASUREMENTS AT HIGH TEMPERATURES. W. D. Kingery. Pp. xii + 416. *New York: John Wiley & Sons, Inc.; London: Chapman & Hall Ltd.*, 1959. 132*s*.

Until a few years ago it was a laboratory curiosity to carry out experiments at high temperatures in the region of 2000°C and beyond. This situation has changed, and there is now considerable research on chemical and physical processes at high temperatures. This advance has demanded new materials, new devices and new techniques. Glass, quartz and the common 'high temperature alloys' cease to be useful for the construction of apparatus above 1100°C, and at temperatures above 1400°C the useful metals are limited to the noble metals and to tungsten, tantalum and molybdenum. The primary construction materials for high-temperature apparatus are the refractories and, in particular, the oxides ThO_2, Al_2O_3, ZrO_2, MgO, and the carbides and nitrides of Si, Ti, Zr and Hf.

Dr Kingery's book is intended to assist high-temperature workers in the design of apparatus and choice of technique most suited to their needs. In this sense, the book is a laboratory manual containing much useful tabulated and graphical data, many very well-produced diagrams and a wealth of practical hints. These latter are of very real value for there is a great deal of 'do-it-yourself' needed to make experiments at high temperatures. Although a limited number of refractory materials are commercially available, many materials required for special purposes have to be made and fabricated by the investigator himself.

The book, however, is not designed as a manual but as a general introduction to property measurements at high temperatures. Each chapter begins with a review of the theoretical principles of the subject under discussion, and at the end of each chapter there is given a very extensive literature survey of the topic. As a result, the book is lengthy and expensive, but should be helpful to teachers and students as well as to research workers in high-temperature studies.

The first three chapters lay the foundations for later development, and deal with the methods of measuring temperature, the properties of laboratory refractories,

and the construction and performance of laboratory furnaces. In later chapters, the author describes and critically evaluates various experimental methods of measuring many of the more important properties of materials at high temperatures. These include physical properties—such as thermal conductivity, emissivity, thermal expansion coefficients, density, thermal stress resistance, elasticity and viscosity; rate measurements of chemical decomposition reactions, of diffusion processes and of the sintering of powders; thermodynamic properties, including heat capacity, latent heat of fusion and vaporization; equilibrium constants; electrical and magnetic properties; surface energy.

The range of topics, evidently, is extensive, and it is a credit to the author that he maintains a good standard of presentation throughout the book. On the other hand, one might question the real advantage of covering so wide a canvas; the book is perhaps too detailed for the general student, too diluted for the expert, and too costly for most.

H. A. SKINNER

VALENCY: CLASSICAL AND MODERN. Second Edition. W. G. Palmer. Pp. xi + 244. *Cambridge: University Press*, 1959. 30*s*.

During the last twenty years the border-line between physics and chemistry has largely been obliterated: purely physical methods of elucidating molecular structure have finally been accepted and have developed at an unprecedented rate; and some appreciation of wave mechanics is now regarded as essential to any understanding of the structure and properties of molecules. The balance of Dr Palmer's well-known book (first edition 1944) had been disturbed by these changes, and the second half, which dealt with 'modern theory,' was ripe for extensive re-writing. The preparation of a new edition afforded the author a unique opportunity.

The result is disappointing. The task of explaining in simple terms the quantum theory of valency is formidable, but the need for a convincing exposition of the subject at an elementary level is desperately urgent. Dr Palmer has not accepted the challenge but has chosen instead to correct and patch-up the original material, doubtless with the aim of making it serviceable for another generation but, one feels, without much enthusiasm.

A preoccupation with the 'spin theory' (Chapter IV), so prominent twenty years ago, now seems out of place. So often does it suggest, quite wrongly, that valence forces arise from a strong 'coupling' of electron spins without pictorial interpretation. For the simplest picture of a chemical bond we must go back to Burrau's (1927) work on H_2^+, where there is only *one* electron, *no* coupling, and the positive nuclei are more evidently held together by a distribution of negative charge between them. This is the picture which expresses the real content of *any* wave-mechanical theory of *any* system and which lends itself admirably to elementary exposition. But the molecular orbital approach which leads most naturally to this interpretation is not even mentioned until Chapter VI (on 'current topics').

Some errors remain, some are newly introduced. On page 185 *et seq.*, for instance, the author confuses symmetry under permutation of electrons with *molecular* symmetry, wrongly describes Ψ^2 as a charge density, and goes on to discuss *Heitler-London* wave functions when molecular orbitals are clearly intended. The corresponding section in the first edition was substantially correct.

The most conspicuous omission is a section on ligand field theory, which is now indispensable to any understanding of bonding in inorganic complexes and which completely rationalizes the older concepts of the theory of electrovalency. Alternative discussions, typified by that of $Fe(CN)_6^{4-}$ (p. 173), are often dangerously unrealistic.

The first half of Dr Palmer's book remains an absorbing account of the development of classical valency theory and of the insurmountable difficulties it encountered. Many readers will regret that equal justice has not been done to the modern theory.

R. MCWEENY

REACTION KINETICS FOR CHEMICAL ENGINEERS. S. M. Walas. Pp. xiv + 338. *New York: McGraw-Hill Book Company, Inc.; London: McGraw-Hill Publishing Company Ltd*, 1959. 74*s*.

There is a large gulf between the academic study of chemical reaction kinetics and the reaction kinetics employed by chemical engineers. Relatively few books attempt to bridge the gap, and indeed this is hardly surprising since the chemist is generally interested in the rate and mechanism of each of the individual steps which the overall process comprises, whereas once the empirical rate-law governing the reaction velocity under his particular conditions has been established, the chemical engineer's interest wanes. He naturally turns then to the heat and mass balances involved and to the choice of the most economical type of unit.

It is not surprising therefore, that the author of this book develops such fundamental kinetics as he requires very rapidly—too rapidly, some may think—and then plunges into the problems of adiabatic reactions, continuous stirred reactors, flow reactors, fluidized beds and similar matters.

As the treatment of these subjects inevitably involves a moderate amount of mathematics, a chapter reviewing differential equations and numerical integration is included. The emphasis is always, and rightly so in a book of this nature, on obtaining the answer to a practical problem—how large a reactor? how long a residence time? and so on.

Heterogeneous and catalytic reactions receive a particularly thorough treatment in view of their industrial importance, and here also the emphasis is on the development of equations useful in practice, rather than in a detailed analysis of the underlying mechanism of such reactions.

For chemical engineering students this book probably contains more than is required for a first degree course, but much of the subject matter will be of value and there are comprehensive sets of problems, but no answers. There is also an appendix somewhat optimistically entitled 'The Literature of Reaction Kinetics.'

Chemical engineers in industry may also find much useful material here, if their particular interests lie in this field, but they, and others too, may find the slightly ponderous treatment a handicap at times.

This is a good book, excellently produced—as one would expect from McGraw-Hill—dealing almost exclusively with the engineering aspects of the subject.

J. A. BARNARD

SOURCE BOOK OF INDUSTRIAL SOLVENTS. Volume III. MONOHYDRIC ALCOHOLS. Ibert Mellan. Pp. vi + 276. *New York: Reinhold Publishing Corporation; London: Chapman & Hall Ltd,* 1959. 80*s.*

How curious it is that a book, the bulk of which is really excellent, can also include the completely banal, as does this volume, the third in a series of source-books on industrial solvents. I quote from the chapter on ethyl alcohol: 'Since nature synthesizes alcohol abundantly through seemingly spontaneous fermentation, it is easy to believe that man must have learned quickly to enjoy its agreeable effects long before the dawn of history. . . . The natural sources of alcohol are fruit juices, sap of certain trees, vegetable and animal substances exposed to the yeast spores carried in the air. Man learned early to repeat the conditions bringing about these magical changes. . . .' This is school-boy science—and not even sixth-form science at that. This sort of writing may be good enough for popular science magazines, but it is out of place in what is intended to be a mature textbook.

And in many respects this book is, indeed, a most mature and useful volume. It is entirely devoted to the monohydric alcohols. As a reference book to their physical properties it is excellent, as were the preceding volumes on pure hydrocarbons and halogenated hydrocarbons, and this series of books is providing a convenient and handy source of information on these substances.

But where the book fails is in its treatment of manufacturing processes. In this respect the book is unbalanced. In the chapter on ethyl alcohol 74 pages are devoted to its production; this includes a 14-page description of the oxo process, although why it should be under the heading of ethyl alcohol is not clear—presumably the author did not know where else to include it. The production of methanol is handled in 8 pages, of *n*-butyl alcohol in one and a half pages, and of isopropyl alcohol in one paragraph; methods of manufacture of the other 44 alcohols discussed in the book are merely mentioned in passing, if at all. A much better method of presentation would be to divide the book into two parts, the first part dealing specifically with manufacturing process, for example fermentation, olefin hydration, Fischer–Tropsch synthesis and oxo process, and the second part dealing with physical properties. It would be better still to publish the two parts separately. Part II dealing with the physical properties would be a most useful and excellent volume which should be on the desks of all chemists. Part I we would be able to forget.

J. L. EDGAR

ADVANCES IN INORGANIC CHEMISTRY AND RADIOCHEMISTRY. Volume 1. Edited by H. J. Emeléus and A. G. Sharpe. Pp. xi + 449. *New York: Academic Press Inc.; London: Academic Books Ltd,* 1959. $12.00, 96*s.*

This book is the first of a series of volumes intended to provide, in the words of the editors, '. . . articles by experts which review the fields of current interest to research workers and which serve, also, to inform the non-specialist of recent progress.' The view is taken that in modern inorganic chemistry there should be an effective integration of structural, kinetic and thermodynamic data with purely descriptive chemistry. This first volume certainly measures up very well to the stated objectives.

The first article deals with mechanisms of redox reactions of simple chemistry and is written by Professor H. Taube. This is a brilliant exposition of a very live subject by an outstanding writer and research worker. The second chapter, by Professor E. O. Fischer and Dr H. P. Fritz, deals with compounds of aromatic ring systems and metals and provides a sound exposition of the subject to which the authors have made such noteworthy contributions. Then follow articles on boron hydrides by Professor Lipscomb; lattice energies by Dr Waddington; graphite intercalation compounds by Dr Rüdorff; the Szilard–Chambers reaction in solids by Drs Harbottle and Sutin; activation analysis by Drs Atkins and Smales; the phosphonitrilic halides by Drs Paddock and Searle and, finally, the sulphuric acid solvent system by Drs Gillespie and Robinson. Each article covers about 50 pages.

A glance at the above titles reveals a fair balance between kinetics, thermodynamics, descriptive inorganic and radiochemical topics. Perhaps it is being too greedy to want an article on modern valency theory applied to inorganic chemistry and, no doubt, this will be provided in future volumes. Perhaps it would be

invidious to single out articles for special comment in such an array but I found Taube's review especially exciting. It must be emphasized, however, that the contributions are all very good and the editors have set a high standard for contributors to future volumes.

The book is well produced and has both an author and a subject index. The price is high but not excessive in view of present trends.

R. S. Nyholm

METHODS FOR THE DETERMINATION OF TOXIC SUBSTANCES IN AIR. (IUPAC). Prepared by J. C. Gage, N. Strafford and R. Truhant. *London: Butterworths Scientific Publications*, 1959. 30*s*.

In my opinion, 30*s*. is a high price for such a small book which at present comprises about 70 pages of script together with table of contents and title page in a Manilla loose-leaf pillar file. Supplements to the present works are projected and a standing order for these is recommended but it is not clear whether the cost of these supplements is extra to the initial outlay or not.

The book opens flat for bench use, which is a great advantage, the print is good and clear but in the absence of an index the methods could have been arranged alphabetically, which would have simplified the finding of a particular method of test.

It is difficult to comment upon the list of substances which appear, but carbon monoxide, methane, arsine and hydrocarbon vapours (petroleum products) are all absent and, in view of the fact that tests for these substances are among those most commonly applied in practice, it is to be hoped that the omissions are only very temporary.

Much of the subject-matter is drawn from the Manual of I.C.I. Practice published in 1956 with a similar title, or from D.S.I.R. leaflets, the methods recommended being well tried and proved but there could be some improvement in the details of preparing solutions of reagents or selection of the reagent. This may be exemplified by reference to chlorine where one is told baldly to dissolve 1·0 g A.R. *o*-tolidine in 100 ml hydrochloric acid and dilute to 1 litre with distilled water when in practice it is advisable to rub the *o*-tolidine to a paste with some of the acid, then add the rest of the acid and dilute to volume.

Likewise in the case of methanol the phenylhydrazine used should not be darker than cream in colour. In other words, although one may purchase A.R. phenylhydrazine and use it, there is a point when it should be discarded from this particular use despite the guarantee of purity on the label.

In the case of nitrous fumes the Griegs–Ilosvay reagent is used and it may be necessary to warm the sulphanilic acid in water, to effect solution. This point is not mentioned.

These may be only small points and not of great importance to experienced workers, but as the Introduction mentions that one guiding point has been the necessity of selection of methods which can be used where there may be no skilled analyst's services available, then fuller details should have been given to guide such less-experienced workers.

The Introduction defines the principles by which the methods have been selected and throughout the text these have been closely adhered to, whilst latitude in the selections of the method of obtaining air samples is allowed. It is to be hoped that room will be found in this work for determination of particle size of dusts and for methods of examination of dusts, which are becoming of increasing importance.

The text is free from typographical errors.

G. V. James

CHEMISTRY TO-DAY. Third edition. A. Allcott and H. S. Bolton. Pp. 185. *London: Oxford University Press*, 1959. 15*s*.

This book is a popular review of the development and progress of chemical science from the days of the alchemist to the present time, due regard being paid to the usefulness of chemical knowledge. It is a well-balanced account of a complex subject and appears to be designed to stimulate interest in chemistry by a lay public. The earlier editions, published in 1936 and 1951, have obviously met with general approval.

Since the appearance of the second edition, several handbooks and monographs on various branches of chemical industry have been published, and some of these have become established in schools and colleges as works of reference. Although one would not expect a book like *Chemistry To-day* to contain the technical data given in these specialist publications, it would appear that full use of recently published information has not been made in revising certain sections of this work. For example, unlike many recent editions of school texts, full use has not been made of data on the manufacture of phosphorus (p. 78); also a few of the simplified explanations of processes quoted in the text seem to 'date' those parts of the book (*e.g.* bottom of p. 48). A few instances of incomplete revision of the text were noted. Thus, the number of known elements quoted on p. 165 differs from that quoted on p. 181. In one or two instances, terminology is used rather too loosely (*e.g.* top of p. 102).

In spite of these faults, the book has much to commend it. Many references occur which are likely to correlate with topics dealt with in chemistry courses in schools. The overall plan is a good one and reference is made to some recent developments, notably in the chemistry of plastics and of soil. In common with other works in the series 'The Pageant of Progress,' the book is well produced and illustrated with many line diagrams and photographs.

B. E. Dawson

Institute Affairs

JOINT ANNUAL MEETINGS WITH THE CHEMICAL SOCIETY

Belfast, 5–8 April, 1960

Many members have already completed and returned the registration forms that were circulated with the January issue of the *Journal*, together with the programme of events for the Joint Annual Meetings to be held in Belfast next April.

The closing date for registration is 29 February, and every effort will be made to comply with the wishes of all those who send in their applications before that date, but it will be recalled that a promise has been given to accord priority to those members who have already given provisional notice of attendance by completing the questionnaire circulated last December (*J.*, 1957, 610). As the number of members and their personal guests entitled to such priority exceeds 500, it may eventually be necessary to refer to the dates of registration when allocating tickets for some of the more popular visits and tours. Any member who wishes to attend the meetings but has not yet sent in his registration form is therefore advised to do so as soon as possible.

It is regretted that no further requests for hotel reservations can be accepted, as all accommodation held under group reservations has already been allocated.

Annual General Meeting, 1960.—As already announced, the 82nd Annual General Meeting of the Institute will be held in the David Keir Building of the University of Belfast, at 10 a.m. on Wednesday, 6 April, 1960. A formal notice of the meeting (with proxy form attached) will be circulated on or before 6 March, together with the Annual Report of the Council for the year ended 30 September, 1959, and the ballot paper for the election of Officers, General Members of the Council, and Censors to take office from the date of the Annual General Meeting. Ballot papers and proxy forms must be returned so as to reach the office of the Institute before 10 a.m. on Monday, 4 April.

The Institute Research Diploma.—A good deal of interest has been aroused by the introduction of this new award. Since the regulations were published in December (*J.*, 1959, 707) there have been many enquiries from employing bodies, technical colleges, potential candidates and others on various features of the scheme. Moreover, applications for registration have already begun to come in, and seven were accepted by the Council at its meeting in January. A good beginning has thus been made on what may well turn out to be one of the most important developments in Institute activities in recent years.

A short article on the Research Diploma, published last month (*J.*, 4), referred particularly to the need for an award of this type as an addition to existing higher degrees and diplomas. It is too soon, however, to add anything by way of interpretation of the regulations or as 'notes for guidance,' except to emphasize two points:

(i) Registration cannot be back-dated to before 1 September, 1959, or the day on which the research was begun, whichever is the later (*J.*, 1959, 706);

(ii) The period of two years of full-time research (or an equivalent period of part-time work) specified in the regulations is the minimum that will be accepted. It is not expected that a majority of candidates will be able to complete work of the required scope and quality in this minimum period.

Recognition of Colleges.—Bournemouth Municipal College of Technology and Commerce has been granted recognition for the training of students to the level of Part II of the Graduate Membership examination. The College was previously recognized for Part I.

Liaison Officers in Technical Colleges.—The following amendments have been made to the list of Liaison Officers in Technical Colleges (see *J.*, 1959, 474).

(P) *London, Regent Street Polytechnic.* Mr C. W. Hyde, Head, Department of Chemistry and Biology (in succession to Dr W. Davey).

(P) *London, Norwood Technical College.* Mr M. A. Fill, Acting Head, Department of Chemistry and Biology (in succession to Dr M. J. Birchenough).

West Ham College of Technology.—Mr L. M. Miall has been nominated by Council to serve as the Institute representative on the newly-established Chemistry Advisory Committee of the West Ham College of Technology.

Benevolent Fund.—The initial response to the annual appeal for support of the Benevolent Fund, which was circulated last December, has been encouraging, and many contributions have been received from members who have not previously supported the Fund.

Any member who intended to respond to the appeal but has not yet done so, is invited to send his contribution to the Honorary Secretary of the Fund at the office of the Institute.

Royal Automobile Club Group Scheme.—Corporate and Graduate Members of the Institute are reminded that a group scheme exists for associate membership of the Royal Automobile Club. Group members receive all the benefits available to individual members of the Club, including road services, legal aid, assistance with tours and technical advice.

The standard annual subscription rates of £2 2s. for cars and £1 11s. 6d. for motor cycles are reduced to £1 11s. 6d. for cars and £1 5s. for motor cycles for

group members; in order to reduce administrative costs for the scheme it is a condition of group membership that subscriptions are paid annually, in advance, by bankers order.

Corporate and Graduate members of the Institute may join the Group at any time; members of the Club who wish to transfer to the group are asked to apply for group membership when their current annual subscription to the Club expires. Further details of the services may be obtained from the group secretary, Mr J. F. Harding, at 30 Russell Square.

Replicas of the Institute's Armorial Bearings.—A number of firms have arranged to manufacture replicas of the Institute's Armorial Bearings, and have submitted specimens for approval by the Council. Members wishing to purchase such replicas for display in their offices or homes are advised, before doing so, to write to the office of the Institute. A list of manufacturers who have agreed to co-operate with the Institute, and particulars of the various designs that have been approved, will then be sent to them.

Journal Back Numbers.—The response to the appeal (*J.*, 1959, 677) for copies of the *Journal* in short supply has been very satisfactory and we cordially thank all who have answered it.

Sufficient copies of all the later parts (*i.e.* from 1944, Part IV onwards) are now held, but further copies of the following are still wanted:

1918, Part I	1923, Part III
1921, Part V	1924, Part III
1922, Part I	1926, Part III

Those able to return their copies are requested to address them to the Assistant Secretary, 30 Russell Square, W.C.1.

Monographs for Teachers.—A new item in this series will be ready shortly, and orders can now be received. It is:

No. 3. *Principles of the Extraction of Metals*, by Dr D. J. G. Ives (6s.)

Approximately double the length of the first two monographs in this series, it contains four main sections—an introductory thermodynamic background, an account of the thermodynamics of pyrometallurgical processes, a discussion of the choice of extraction methods and a description of some typical processes. It concludes with a list of more than 30 significant sources and references.

This monograph, while being written for teachers and advanced students of chemistry, will also be of considerable interest to metallurgists.

Binding of Journals.—Members and subscribers are reminded of the special arrangements for the binding of journals in green buckram at the price of 11s. 6d. per annual volume, including return postage. Those making use of this service are advised not to send Volume 83 (1959) for binding until they receive the *Annual Report of the Council* for the year ended 30 September, 1959, which should be included in this volume.

All enquiries should be addressed to W. Heffer & Sons Ltd, Hills Road, Cambridge.

Boots Booklovers Library.—Members are reminded that subscriptions run for 12 months from date of payment and that those who have held tokens for a year should renew their subscriptions. Fresh application forms can be obtained from the office of the Institute. Members are no longer limited to two volumes. Preferential rates are as follows:

Class A books at 27s. 6d. per volume for 12 months.

Class B books at 13s. 0d. per volume for 12 months.

Chemical Society Library.—All members, both corporate and non-corporate, are reminded that they have full borrowing rights from the Chemical Society Library, Burlington House, Piccadilly, London, W.1. Enquiries about books, journals, photocopies and the like, and all bibliographical enquiries should be addressed to the Librarian. Other enquiries should be addressed to the Assistant Secretary (Scientific), 30 Russell Square, London, W.C.1.

PERSONAL NOTES

News of Hon. Fellow

Lord Adrian, O.M., F.R.S., at a recent meeting of Trinity College, Cambridge, was prolonged in the office of Master for the maximum period of 5 years from 30 June next.

Honours and Awards

Professor D. Burton, M.B.E., *Fellow*, was elected an Honorary Member of the Society of Leather Trades' Chemists during a conference held at the University of Leeds on 24 September, 1959.

Mr J. H. Carrington, *Fellow*, technical director, Anchor Chemical Co. Ltd, has been awarded the Hancock Medal of the Institution of the Rubber Industry for 1959.

Dr J. W. Clarke-Lewis, *Fellow*, University of Adelaide, has been awarded a bursary under the Royal Society and Nuffield Foundation Commonwealth scheme to enable him to continue his studies on the chemistry of natural products at Imperial College, London.

Dr A. J. Lindsey, *Fellow*, head of the Department of Chemistry, Sir John Cass College, has been awarded the degree of D.Sc. of the University of London for his work in the fields of combustion and analytical chemistry.

Mr J. Mardon, *Associate*, of Anglo Paper Products, Quebec, has been granted the Insignia Award in Technology of the City and Guilds of London Institute.

Dr J. P. Riley, *Fellow*, has been awarded the degree of D.Sc. by the University of Liverpool for his work on analytical chemistry and geochemistry and some earlier work on fat chemistry.

Professor Cyril Tyler, *Fellow*, of the University of Reading, has been awarded the degree of D.Sc. by the University of Leeds for studies on eggshells and the mineral metabolism of poultry.

Societies and Institutions

Dr J. I. M. Jones, *Fellow*, technical manager and research director of Crookes Laboratories Ltd, has been re-elected Chairman of the Biological Methods Group of the Society for Analytical Chemistry.

Sir Patrick Linstead, C.B.E., F.R.S., Meldola Medallist, *Fellow*, has been appointed a Vice-President of the Royal Society.

Mr E. W. Moore, *Associate*, senior chemistry master, King's Norton Grammar School for Boys, Birmingham, has been elected Chairman of the Science Masters' Association.

Dr A. R. Urquhart, *Fellow*, has been appointed Chairman of the Council of the Textile Institute. He recently received the Service Medal of the Textile Institute.

Educational

Dr W. L. F. Armarego, *Associate*, has resigned from his position as senior demonstrator at the University of Melbourne and taken up a research fellowship at the John Curtin School of Medical Research, Australian National University, Canberra, in the department of medical chemistry.

Dr F. Fairbrother, *Fellow*, Reader in organic chemistry and assistant director of the chemical laboratories, University of Manchester, has been granted the status of Professor and appointed to the chair of inorganic chemistry.

Mr A. C. M. Finch, *Associate*, has relinquished his post at the Queen Elizabeth Grammar School, Wakefield, to take up a research fellowship at the Royal Military College of Science, Shrivenham.

Dr M. E. Foss, *Fellow*, head of the chemistry and metallurgy department, Coventry Technical College, has been appointed vice-principal and head of the chemistry, metallurgy and textiles department, Lanchester College of Technology, Coventry. He will take up his new duties on 1 April.

Professor D. O. Jordan, *Fellow*, of the University of Adelaide, is now on study leave and has arrived in London where he expects to spend some time at University College with Professor R. S. Nyholm and at the Chester Beatty Institute for Cancer Research with Professor J. A. V. Butler, assisted by an award under the Royal Society and Nuffield Foundation Commonwealth Bursaries scheme. Professor Jordan also hopes to visit universities on the Continent and in the U.S.A.

Professor R. J. W. Le Fèvre, F.R.S., *Fellow*, of the University of Sydney, has been visiting the U.S.A. and will be in London from 14 February to 13 March.

Professor G. M. Nabar, *Fellow*, Professor of textile chemistry, University of Bombay, has been appointed R. K. Mody Professor of chemical technology and director of the department of chemical technology at the University.

Professor J. Monteath Robertson, F.R.S., *Fellow*, Professor of chemistry at the University of Glasgow, has been appointed a member of the University Grants Committee.

Dr J. K. Skelly, *Associate*, senior lecturer, College of Technology, Belfast, has been appointed an additional deputy chief colourist by the board of Ciba Clayton Ltd, Manchester.

Dr D. B. Smith, *Associate*, has taken up an appointment as senior lecturer in food technology at the Borough Polytechnic.

Dr N. F. Taylor, *Associate*, has resigned his D.S.I.R. (NATO) Fellowship at the department of biochemistry, University of Oxford, and taken up an appointment as lecturer in organic chemistry in the department of chemistry, College of Technology, Bristol.

Mr P. S. Uzzell, *Associate*, has been appointed assistant master at Manchester Grammar School.

Mr J. M. Wilson, *Associate*, who relinquished his post at Makerere College in June, 1959, for reasons of health, has recently accepted appointment as senior lecturer in physical chemistry at the College of Technology, Liverpool.

Public and Industrial

Dr H. O. Askew, O.B.E., *Fellow*, has left the Cawthron Institute, Nelson, to take up an appointment with the New Zealand Breweries Ltd, Wellington.

Mr G. E. Boynton, *Associate*, has left Ciba (A.R.L.) Ltd and taken up a post as chemical engineer at the Technological Research Station of Spillers Ltd.

Mr A. H. Brown, *Associate*, has left F. W. Berk & Co. Ltd, to take up an appointment as an alkali inspector with the Ministry of Housing and Local Government at Bristol.

Mr A. S. Cook, *Fellow*, has relinquished his post as industrial chemist, Ministry of Commerce, Eastern Nigeria, and has been appointed deputy director, Federal Institute of Industrial Research, Nigeria.

Dr A. P. C. Cumming, *Fellow*, who was until recently head of the chemical engineering department of Laporte Chemicals Ltd, has been appointed to the Board of the John Bull Rubber Co. Ltd as technical director.

Mr J. B. Davis, *Associate*, has relinquished his post with A. Boake, Roberts & Co. Ltd to take up an appointment as general manager of the Ellesmere Port Works of the Flintkote Company Ltd.

Mr N. A. Edge, *Associate*, has relinquished his position with the National Coal Board to take up an appointment as a research chemist with Laporte Titanium Ltd.

Dr P. S. Fitt, *Associate*, has been appointed a visiting research fellow at the Sloan-Kettering Institute for Cancer Research, New York.

Mr S. D. Gangolli, *Fellow*, has returned from Uganda and rejoined T. McLachlan & Partners as a senior analyst.

Dr J. H. Hamence, *Fellow*, has been appointed to serve on the Ministry of Agriculture advisory committee on poisonous substances used in agriculture and food storage.

Mr Edgar Hammond, *Associate*, has been appointed technical librarian/information officer to the Research Council of the British Whiting Federation.

Mr A. F. Heather, *Associate*, has taken up an appointment with Du Pont (U.K.) Ltd, Maydown Works, Northern Ireland.

Mr E. D. Henley, *Fellow*, has been appointed area chemist, British Railways Research Department, Derby.

Dr W. G. Hiscock, *Fellow*, a director of Consolidated Zinc Group Ltd, has been appointed chairman of the Lead Development Association for 1960.

Mr J. D. Howie, *Fellow*, will shortly take up the post of industrial adviser on raw materials, on loan to the Government of Pakistan under the Colombo Plan technical co-operation scheme.

Dr E. M. Hunt, *Associate*, has resigned from Shell Chemical Co. Ltd to join the Board of Utilex Limited, Kingston-on-Thames.

Mr F. C. Hymas, *Fellow*, Chairman of the London Section, has been appointed chief chemist of Phillips Yeast Products Limited.

Sir Harry Jephcott, *Fellow*, during his visit to Malaya, addressed the Local Section of the Institute at their Annual General Meeting, speaking on the activities of the D.S.I.R. He is now visiting Australia and New Zealand and will proceed to the U.S.A. before returning home in April.

Mr E. D. Jones, *Associate*, has been transferred from his post with Alba S.A., Brazil, to become managing director of Placco Colombiana Ltda, Cali, Columbia, an affiliate of the Borden Chemical Company, New York.

Mr K. J. Kearney, *Associate*, has been appointed chief chemist, Provincial Traders Pty Ltd, Queensland, Australia.

Dr V. A. Knivett, *Associate*, has left the Water Pollution Research Laboratory, Stevenage, to join the staff of Twyford Laboratories Ltd, a new research institute set up by Arthur Guinness, Son & Co. Ltd to carry out academic research in microbiology and biochemistry.

Mr R. A. S. Lacey, *Associate*, of Polak & Schwarz (England) Ltd has been appointed a director.

Professor D. R. Llewellyn, *Fellow*, of University College, Auckland, has been appointed to the Atomic Energy Committee as a representative of the Senate of the University of New Zealand.

Mr D. A. B. Llewelyn, *Associate*, has been appointed a deputy chief scientific officer (temporary) in the chief scientist's division, Ministry of Power.

Mr H. W. Marson, *Fellow*, has left Carbide Industries Ltd to take up an appointment in the chemical engineering division of Constructors John Brown Ltd.

Mr W. J. Murphy, *Fellow*, has left Peter Spence & Sons Ltd to take up an appointment as works manager with William Blythe & Co. Ltd, Church, Lancashire.

Dr G. T. Newbold, *Fellow*, has relinquished his post as lecturer in the department of chemistry, Royal College of Science and Technology, Glasgow, and taken up an appointment as head of the organic chemistry department at the Chesterford Park Research Station of Fisons Pest Control Ltd.

Dr A. E. Owen, *Associate*, has taken up an appointment with the Solid State Physics Group of the Westinghouse Research Laboratories (Westinghouse Electric Corporation) Pittsburgh.

Mr S. Pickles, *Associate*, has relinquished his post as head of the physical chemistry section at the Scottish Divisional Laboratories of the National Coal Board to take up an appointment with the U.K. Atomic Energy Authority at Dounreay.

Mr J. Pickthall, *Fellow*, has been appointed a director of Polak & Schwarz (England) Ltd.

Mr F. Pollard, *Associate*, has left the National Coal Board to take up a post as district chief scientist with the Australian Coal Association (Research) Limited.

Dr Bernard Raistrick, *Fellow*, research director, Scottish Agricultural Industries Ltd, has been appointed a full-time executive director of Associated Chemical Companies with particular responsibility for scientific matters. He will take up his new post on 1 April.

Mr W. H. Ritchie, *Fellow*, of Monsanto Chemicals Ltd, has been appointed a development manager, projects. He will be responsible for progressing the manufacture of new products and for development planning.

Mr J. B. D. Robinson, *Fellow*, of the Coffee Research Station, Kenya, has been promoted to principal scientific officer, Overseas Civil Scientific Service, Research Branch (Agriculture).

Dr H. A. Shah, *Fellow*, has been appointed director of the Small Industries Service Institute (Ministry of Commerce and Industry), New Delhi. He took up his new post on 7 November, 1959.

Mr H. D. Thornton, *Fellow*, City Analyst, Dublin, has been appointed chairman of the Food Advisory Committee by the Minister of Health, Republic of Ireland.

Sir Owen Wansbrough-Jones, K.B.E., C.B., *Fellow*, has been appointed a director of the British Oxygen Co. Ltd.

Retirements

Mr W. A. Damon, C.B.E., *Fellow*, has retired from service with the Ministry of Housing and Local Government. He was a Member of Council in 1937–40.

Dr A. T. Green, C.B.E., *Fellow*, director of research, British Ceramic Research Association, retired on 31 December, 1959. Dr Green was a Member of the Council in 1945–48 and 1950–53.

Section Activities

Aberdeen and North of Scotland

Stereochemistry of the Transition Metals. On 16 November, 1959, Professor R. S. Nyholm, F.R.S., of University College, London, addressed a joint meeting on 'The Stereochemistry of the Complex Halides of the Transition Metals.' The lecture began with a discussion of the principles governing stereochemistry in general and of the transition elements in particular. The importance of the number of *d* electrons was stressed, and particular attention was paid to those metals for which both a regular tetrahedral and an octahedral arrangement were to be expected. It was pointed out that factors other than simple electrostatic effects were also important and complexes of the type $(FeCl^{--})_4$ and $(NiCl^{--})_4$ were discussed; the latter form an almost perfect tetrahedron. The spectral and magnetic properties were dealt with in some detail. It was concluded that, important as the electrostatic effects are, covalent bonding can be decisive in complexes of this type.

Chemical Kinetics. Professor K. G. Denbigh, of the University of Edinburgh, spoke to a joint meeting on 10 December on 'Chemical Kinetics in Relation to Large Scale Production.' After detailing various types of reaction vessels Professor Denbigh described the ways in which the kinetics of reactions in these vessels differ from those in a batch reaction and how maximum yields of products might be obtained.

Christmas Lectures. On 22 and 23 December Christmas Lectures to senior school children were given by Dr C. A. Beevers, of the University, Edinburgh, who took as his subject 'Crystals, or Atoms and Molecules in Unison.' The lectures and numerous demonstrations were greatly enjoyed by the audience of about 250 children, and at the end of the second lecture the vote of thanks was proposed by Ronald Maitland of Aberdeen Academy.

Belfast and District

Christmas Lecture. The Annual Lecture and Demonstration organized by the Section for senior pupils of schools in Northern Ireland took place on 29 December, in the Chemistry Lecture Theatre of Queen's University, Belfast. Mr J. K. Foreman, who is in charge of analytical research work at Windscale Atomic Energy Establishment, Cumberland, spoke on 'Chemistry in Atomic Energy.' Dr D. W. Ockenden, a senior scientific officer in the Chemical Services Department at Windscale, carried out the demonstrations. Dr. R. J. Magee was in the Chair. Mr Foreman began by defining the role of the chemist as that of providing the materials (fuel elements, canning materials, moderators and coolants) to the specifications and purity required for a given type of reactor, together with the basic fundamental chemistry of the materials and processes involved in so doing, and the development of means for treating irradiated fuel to recover fissile substances.

He pointed out the peculiar and intricate problems involved in the preparation of pure fuel elements virtually free from such neutron absorbers as boron and gadolinium and in devising methods for the reliable determination of such substances present to a few parts per million.

He illustrated how it was possible to process irradiated fuels to obtain the minute quantities of transuranic elements in a pure form for subsequent use.

Many facets of the fundamental chemical research carried out at Harwell and other sites were dealt with in detail to show how every branch of chemistry was involved.

Mr Foreman concluded by pointing out the special hazards of working with radioactive materials and the precautions taken to reduce these to the minimum.

Dr Ockenden illustrated the special apparatus and techniques employed in radio-chemistry by a series of experiments. Two films, 'How a Reactor Works' and 'Uses of Radioactive Isotopes,' ended the meeting.

I. W. Milligan proposed the vote of thanks, which was carried with enthusiastic applause.

Birmingham and Midlands

Christmas Lectures for Young People. The Christmas Lectures were held on 31 December and 1 January in the Physics Lecture Theatre of the University of Birmingham. The lecturer was Professor M. Stacey, F.R.S., and his subjects were on the first day, 'Sugars and Starches,' and, on the second, 'Fluorine—Halogen on the Move.' Both lectures were accompanied by numerous demonstrations and exhibits. An appreciative audience of over 300 young people, mostly from the VI forms of Midland Grammar Schools, attended on each day; and for the second year running there was a greater demand for tickets than there were seats available.

Dublin and District

Biological Methylation. A meeting of the Section was held on 11 November in the Chemistry Department, University College, Dublin. The Chairman, Mr H. D. Thornton, introduced Dr G. A. Maw, who gave a lecture on 'Biological Methylation.'

The lecture was devoted to a discussion of the transfer of methyl groups between compounds in biological systems. After a brief survey of the various types of *N*-methyl, *S*-methyl and *O*-methyl compounds that occur naturally, Dr Maw summarized the early experimental evidence of biological methylation, from the work of His in 1887 on the *N*-methylation of pyridine in the dog, to Professor Challenger's experiments with moulds. The speaker then described the now classical nutritional and isotope experiments of du Vigneaud and his school on the interchange in the animal of methyl groups

between choline, glycine betaine and methionine, work which led to the recognition of the dietary importance of the methyl group and also to the development of the concept of transmethylation.

Subsequent developments in this field arose from experiments with tissue slices and extracts in place of whole animals, and culminated in the discovery, by Cantoni in 1951, that the active form of methionine in its methylation reactions is a sulphonium compound, *S*-adenosylmethionine, akin in structure to other methylsulphonium compounds, or thetins, which had previously been shown to be active in the whole animal as dietary sources of methyl groups. This finding made it possible to classify all the known biological methyl donors as methylated sulphonium or quaternary ammonium compounds.

More recent work on the methylation reactions involving *S*-adenosylmethionine was described, including the methylation of purines and histamine, and the *O*-methylation of adrenaline and noradrenaline. This last reaction may have far-reaching physiological significance as it is apparently the primary mechanism in the body for the termination of the action of these hormones. The speaker concluded with a description of the enzymes concerned in methionine synthesis by the methylation of homocysteine, and discussed possible mechanisms for the participation of enzymes in transmethylation.

After a discussion Mr Thornton proposed the vote of thanks.

DUNDEE AND DISTRICT

Diquinones. At a lecture on 20 November, 1959, at Queen's College, Dundee, Dr R. H. Thomson of the University of Aberdeen delivered a lecture entitled 'Diquinones.'

The lecturer began by emphasizing the great reactivity of simple benzoquinones and naphthaquinones, illustrated by a variety of reactions with diverse reagents. This led to a consideration of diquinones, some of which might be expected to be even more reactive. These were divided into four groups, (*a*) those in which the quinone rings are separated by a chain of several carbon atoms, (*b*) diquinones of polycyclic aromatic hydrocarbons in which the quinone rings are rigidly separated by the framework of the molecule, (*c*) those containing two quinonoid rings fused together and (*d*) diquinones in which the quinone rings are directly linked by a C–C single bond. Quinones of types *a* and *b* show no unusual properties. Type *c* shows normal quinonoid activity to an enhanced degree and those of type *d* sometimes show remarkable behaviour as a result of interaction of the two closely-linked quinone systems. Three examples of the latter were then considered in the light of recent experiments, namely, the rearrangement of 4,4′-dimethoxydiphenyl-2,5:2′,5′-diquinone to a dibenzofuranquinone (Erdtman, 1934) and of 2-hydroxy-4,4′-dimethoxydiphenyl-2,5:2′,5′-diquinone to a coumaranylidene-butenolide (Posternak, 1956), and the conversion of oosporein (a dibenzoquinone) to tomichaedin (a naphthaquinone) by potash fusion (Nishikawa, 1952).

In conclusion, Dr Thomson referred to naturally-occurring polyquinonoid materials, and discussed briefly the hardening of insect cuticle, the formation of humic acids in soil, and the biogenesis of melanins.

The Chairman, Dr R. Roger, then called upon Mr W. Johnston to propose the vote of thanks.

Application of Dyes. On 16 December, 1959, at Queen's College, Dundee, Mr B. Kramrisch, of Ciba Clayton Ltd, assisted by Mr B. W. Ellison, gave the Christmas Lecture for children on 'The Application of Dyes.'

Mr Kramrisch stressed the importance of colour in everyday life with reference to clothing, furnishings, paint and wallpaper. The wide usage of colours for identification purposes was exemplified by blazers, badges, scarves and ties for schools, colleges and clubs, 'flashes' on military uniforms, coloured cables for wiring telephones, standard coloured paints for identifying service pipes in industry and for medical gas cylinders to identify anaesthetics, coloured paper and boards for ready identification of postage stamps, and bus and cinema tickets, and to facilitate filing in offices.

After discussing natural dyes, the lecturer outlined the discovery of Mauveine in 1856 and indicated the origin and development of the coal-tar dyestuffs industry.

He described several classes of dyes and their application and use, indicating the increased demand for fastness and how this has been met by the development of new types of dyes. The use of mordants in dyeing was explained and practical demonstrations of vat and azoic colour dyeing were given. The development of high-temperature dyeing was outlined and its value in dyeing the newer fibres, especially Terylene, explained.

This was followed by examples of the dyeing of mixed materials and illustrated by practical demonstrations of multicolour dyeing of unions of viscose and acetate rayons and of nylon and Terylene.

Printing of textiles by block, screen and roller was outlined.

In conclusion, reference was made to the dyeing of various types of non-textile material, including plastics, paper, leather, furs, feathers, soap, foodstuffs and anodized aluminium, illustrated by examples.

The Chairman, Mr J. Smart, called upon Robin Strang, a senior pupil of Perth Academy, to propose the vote of thanks to the lecturer and his assistant.

EAST MIDLANDS

Colour Photography. A well-attended meeting was held at Derby on 19 November when Mr D. P. Ayres gave a lecture on 'The Principles of Colour Photography.'

Colour film is designed to record colours in terms of the amounts of red, green and blue light present.

Each film contains three layers of photographic emulsion, sensitive to red, green and blue light, respectively. After exposure this film is either developed in a colour developer to form a colour negative, or a silver image is first produced and the remaining silver halide converted to a positive dye image. Cyan, magenta and yellow dyes are formed in the red, green and blue sensitive layers respectively, to control the amounts of red, green and blue light in the final image. By the use of similar materials, prints, transparencies or duplicates can be obtained from both colour negatives and reversal transparencies.

To compensate for the imperfections of the dyes used, a colour-masking system can be used in the negative–positive process.

The exposure of each layer of a reversal material has to be accurately controlled. A change of as little as a sixth of a stop in the sensitivity of one layer can produce a noticeable change in colour balance. Hence reversal materials are made for use with particular light sources. If used with other light sources, correction filters are necessary.

The exposure latitude of reversal colour film is small. Fortunately the most important factor is the light incident on the scene. Thus, under normal daylight conditions, it is possible to use a simple exposure chart and obtain excellent results.

When taking colour photographs it is usually desirable for the lighting contrast of the scene to be small. This is important when the subject contrast is large. It is of greatest importance when colour prints are required.

By noting a few simple rules of the kind outlined above, anyone can succeed in taking colour photographs.

The lecture was well illustrated with slides and after a discussion, reflecting the keen interest of the audience, the vote of thanks was proposed by Mr M. S. J. Twiselton.

Infra-red Spectroscopy. This was the subject of the next meeting of the Section, held jointly with local members of the Chemical Society at Nottingham on 10 December. Although the meeting appeared to coincide with the onset of wintry conditions, there was a large audience present to hear Dr L. J. Bellamy deliver his lecture.

In the field of large molecules, infra-red spectroscopy is primarily a tool for the solution of chemical problems. Advances therefore are of two kinds: there are those which sharpen the tool and widen its general usefulness, and there are advances in chemistry itself made possible by the use of this technique. The talk reviewed briefly both these topics.

Advances in structural diagnosis are taking place in several different ways. The fingerprint region of the spectrum, which has previously been only of interest for a final identification, is now being developed by the use of specialist correlations applicable only within a given class of compound but extremely useful for diagnosis as long as it is known that the compound is of this type. Advances in our understanding of the origins of group-frequency shifts have also led to a more scientific application of correlation data, and have opened up interesting new applications in the determination of physical properties, such as reaction rates. Intensity studies are also yielding more powerful methods of diagnosis. Finally a new method for structural group identification was described; this depends on the different behaviour shown by some absorptions when these are studied in a variety of solvents.

One of the most promising advances in the chemical field is in stereochemistry. It has long been possible to differentiate between axial and equatorial substitution in selected positions about the steroid nucleus, but recent studies have shown that the puckering and folding of large rings with increase in size of the ring can be systematically studied in this way. So also can steric hindrance effects through the use of solvent association effects. In more general fields, such as biochemistry, some particularly valuable results are being obtained from detailed spectroscopic studies with bacteria and viruses.

Dr Bellamy's vigorous style was much appreciated by the audience and after a stimulating discussion the vote of thanks was proposed by Dr C. J. Timmons.

Glasgow and West of Scotland

Ladies' Evening—Cosmetics. On 8 January a joint meeting was held with local members of the Society of Chemical Industry in the Royal College of Science and Technology. Dr W. A. Caldwell, Chairman, introduced Dr R. H. Marriott of County Laboratories Ltd. Dr Marriott then gave an interesting lecture on 'Cosmetics,' a summary of which has already appeared in the *Journal* (1959, 528).

After a discussion Dr J. Sword proposed the vote of thanks.

Leeds Area

Christmas Lectures. A Christmas Lecture on 'Radioactivity' for sixth-form pupils in secondary schools was given under the auspices of the Section by Dr D. R. Stranks, lecturer in radiochemistry in the University of Leeds. The response to this new venture was so remarkable that Dr Stranks very kindly volunteered to give the lecture twice, and the audiences on 7 and 8 January in the Chemistry Lecture Theatre of the University together totalled nearly five hundred. By a profusion of experiments with the aid of Geiger counters, the lecturer demonstrated the existence of radioactivity in common minerals and potassium salts, the measurement of its decay in radioactive iodine, the amount of screening required to absorb α- and β-particles and γ-radiation and the consequent application of radioactivity to detect such phenomena as variations in the

thickness of paper. A diffusion cloud chamber made visible the passage of charged particles and a beam of electrons was deflected by a magnet. Finally activation analysis was employed to detect the presence or absence of silver in 'silver' coinage, and the instruments were put to baser uses in spotting the aces in a pack of cards dealt face downwards. The audiences were warmly appreciative of Dr Stranks's delightfully informal presentation, and the interest aroused was amply evident in the way in which they crowded round the lecture bench afterwards to ask numerous questions and to examine the apparatus at close quarters.

LIVERPOOL AND NORTH-WESTERN

Stereochemistry. On 3 December, 1959, at the College of Further Education, Widnes, Dr W. B. Whalley, Reader in organic chemistry at the University of Liverpool, lectured on 'Stereochemistry.' His audience included a number of students from the College. Dr Helena Bradbury was in the Chair.

The lecturer outlined the significance and importance of stereochemistry in organic molecules by reference to S_N1, S_N2 and certain stereospecific reactions. Elimination and addition reactions, together with 1 : 2-shifts, were illustrated with suitable examples from the cyclohexanes.

Methods for the correlation of configuration and for the determination of absolute configuration, including the method of optical rotatory dispersion, were discussed.

There was a short discussion and, in reply to questions, Dr Whalley strongly recommended the use of molecular models as an aid to the teaching of stereochemistry; he thought that without them a proper understanding of the subject was virtually impossible.

The vote of thanks was proposed by Dr F. E. Coleman.

Reactive Smokeless Fuels and Chemicals from Coal. A joint meeting was held with the Institute of Petroleum at Blossom's Hotel, Chester on 16 December, under the chairmanship of Mr C. N. Thompson, the lecturer being Mr C. E. Needham of Coalite and Chemical Products Limited.

A brief comparison was made of the high and low temperature systems of carbonizing coal. The primary object of low-temperature carbonization was to produce a solid smokeless fuel which was sufficiently reactive to be able to supplant coal in all types of domestic heating systems, particularly the simple open fire, without the need to alter or replace existing appliances.

The apparatus used for the determination of reactivity of solid fuels was illustrated and described, and C.A.B. (critical air blast) reactivity indices were quoted for various solid fuels.

Results of radiation measurements from open fires showed contrasts between the ease of ignition and rate of pick up of fuels produced by low and high temperature carbonizing systems.

After reviewing the early development of the low temperature carbonizing industry, the speaker described the design and operation of plant used for the production of Coalite and Rexco; mention was also made of processes at present being developed by the National Coal Board.

From the Coalite process, the yields per ton of coal were said to be approximately 14 to 15 cwts of Coalite, 16·5 gal of coal-oil, 3·5 gal of crude petrol, 4,000 cu. ft of gas at 700 Btu/ft^3, and 34 gal of aqueous liquor.

The Central Refinery at Bolsover was said to process about 12 million gal of coal-oil and 2·5 million gal of motor spirit per year.

The compositions of the various primary products were quoted, together with comprehensive data on a very wide range of monohydric phenols which were recovered from the oils by extraction with caustic soda.

Dihydric phenols were recovered from the aqueous liquor by extraction with butyl acetate.

The various phenols found applications in the production of phenol–formaldehyde resins, plasticizers, disinfectants, wetting agents, antiseptics, inhibitors, pharmaceutical products and the like. Some of the phenols were further processed at the Bolsover Refinery to give a range of chlorinated phenols, phosphate esters and tertiary butyl catechol.

In conclusion, Mr Needham said that the low-temperature coal-carbonizing industry had been based on the beliefs that the open fire will continue as the most popular method of domestic heating in this country; the desire for clean air will arouse increasing public support and will introduce a new way of life; the cokes made by conventional high-temperature carbonizing processes are not sufficiently reactive to satisfy the average housewife as a smokeless substitute for coal; the higher thermal efficiency, cleanliness and convenience of these semi-coke 'premium fuels,' compared with coal, more than balance the difference in price per ton; to recover the smoke-producing materials from coal is the sensible thing to do : valuable by-products are recovered and yet the coal loses none of its effective heating value for the purpose of domestic open-fire heating.

A vigorous discussion was opened by Mr G. H. Turner, and the vote of thanks was proposed by Dr Helena Bradbury who also expressed appreciation to the officers of the Institute of Petroleum for having arranged the meeting.

LONDON

Annual General Meeting. The Section's A.G.M. was held at Shell-Mex House on 18 November, 1959 Mr F. C. Hymas was in the Chair. The Committee' and Treasurer's reports were approved, and the following Officers and Members of Committee were elected: Chairman, Mr F. C. Hymas; Vice-Chairmen, Messrs P. A. Raine and A. J. Turnbull; Hon. Treasurer, Mr P. F. Corbett; Hon. Secretary, Mr G. C. Ackroyd; Hon. Assistant Secretary, Mr W. H. Bennett; Members

of Committee, Drs R. A. Jeffreys, D. B. Lisle, S. A. Miller, J. H. Pryor and J. E. Salmon, and Mr H. Murray.

Dr H. G. Smith and Mr A. H. Thorneloe were elected Hon. Auditors. Mr D. M. Freeland then presented the report of the Hon. Almoner, and the desirability of interesting more members in the work of the Committee so that more of them, especially younger ones, should seek election, was briefly discussed. It was pointed out that for some time now the number of candidates had equalled the number of vacancies, and there appeared to be little eagerness to serve on the Committee.

After the formal business was concluded there was a film show. The films, introduced by Dr Pryor, were 'Principles of Chromatography,' 'A Vitamin Emerges,' 'Beauty in Trust' and 'Glass Makers.'

Scientific Examination of Paintings. A joint meeting of the Cambridge University Chemical Society and the Section was held on 20 November, 1959, in the Lensfield Road Laboratories, Cambridge. Dr F. G. Mann, F.R.S., welcomed the visitors and then handed over to Mr Hymas. Mr Hymas introduced the lecturer, Dr A. E. A. Werner of the British Museum.

Dr Werner's lecture was based on his well-known monograph (*Lect. R. Inst. Chem.*, 1952, No. 4) and was illustrated throughout with slides.

After Dr Werner had answered a number of questions, Dr J. Biggs proposed the vote of thanks.

Veterinary Problems and Chemistry. A meeting was held jointly with the Dartford and District Branch of the Pharmaceutical Society on 23 November, 1959, at the N.W. Kent College of Technology, Dartford. Mr M. P. Earles took the Chair and introduced the lecturer, Mr S. L. Hignett.

Mr Hignett began by pointing out that veterinary scientists owe a great deal to chemists who help both in the diagnosis of and research into the diseases of animals. His lecture was devoted to two groups of problems only, toxicity and metabolic disorders.

A century ago many cases of animal deaths were thought to be due to poisoning by plants. Such cases are rare today and indeed it is doubtful if plant poisoning has ever been so prevalent as has been thought. Mineral poisoning from sprays, paint, mineworkings and other industrial sources is the main cause of loss. Lead poisoning (often caused in calves through the licking of old paint) is diagnosed by chemical analysis of parenchymatous (kidney) tissue. Fluorosis, causing both bone and tooth disorders, is diagnosed by demonstrating fluorine in urine. The feeding of Al_2O_3 as a dietary supplement is a means of preventing fluorosis.

One case of plant poisoning described by Mr Hignett was found to be due to the presence of oxalic acid in mangold and sugar-beet tops after long spells of dry weather. Recognition of the symptoms and treatment by drenching with chalk were often too late, but the trouble could be prevented or at least alleviated by allowing the tops to wilt before feeding and by sprinkling with chalk in wet weather.

Metabolic disorders are increasing, especially with progressive farming, and the lecturer described some of these. Milk fever is now treated by injection with calcium borogluconate to increase the blood calcium level. Hypomagnesaemia is often found to occur among animals grazing on pastures fertilized heavily with nitrogen and potash. It has been found that the use of certain fertilizers can reduce the availability of magnesium. Copper deficiency sometimes arises on pastures where the herbage contains an unusually high proportion of molybdenum.

Finally the lecturer spoke on the conception rate in cattle, which depends on three factors: infection, heredity and environment, the last including nutrition. Mr Hignett mentioned the vast amount of work that has been done—the conducting of surveys, the study of problem herds and the experiments in planned feeding, and showed a number of lantern slides to illustrate this. For example, the evidence shows a relationship between fertility on the one hand and dietary phosphorus levels and the vitamin D status on the other. Evidence also exists to show that an enzyme system depending on a trace element can be upset by an excess of that element.

After a number of interesting questions had been answered, Mr J. R. Barr proposed the vote of thanks to Mr Hignett for a most instructive lecture. This was seconded by Mr L. J. Walker who also thanked the College authorities for the facilities granted.

MANCHESTER AND DISTRICT

Laboratory Equipment Exhibition. An exhibition of laboratory equipment was held at the Manchester College of Science and Technology during January. This annual event has proved exceedingly popular in the past and this year's exhibition was no exception. Displays of laboratory equipment and some of the newer instruments provoked great interest, and an excellent display of scientific books was also on show. During the course of the exhibition, about 1,000 visitors were admitted, and the Section is grateful to Mr J. H. Young and his colleagues for the success of this event.

Annual General Meeting. The A.G.M. was held on 8 January with Dr L. R. Ridgway in the Chair. The new committee was declared elected, the number of nominations being sufficient to fill the number of vacancies. The Section appreciates the fact that Dr Ridgway has again agreed to serve as Chairman.

MID-SOUTHERN COUNTIES

Infra-red Spectra. On 16 October a meeting was held jointly with the Chemical Society and the University Chemical Society at the University of Southampton. Dr L. J. Bellamy of the Ministry of Supply spoke on

'Applications of Chemistry in the Interpretation of Infra-Red Spectra."

The interpretation of the spectra of large molecules has been based on a wholly empirical procedure because no mathematical treatment is possible. However, so much information is now available that it is possible, by the application of basic chemical principles, to see an underlying pattern of frequency behaviour. Thus it can be shown that X-H frequencies depend uniquely on the charge on the nucleus and on the degree of electronic shielding. Each element has therefore a characteristic X-H frequency depending on the position of X in the periodic table. Changes of hybridization of X also influence the frequencies so that unsaturation or strain will cause them to alter in a predictable manner.

In addition to these inductive effects, conjugation or mesomerism also influence the frequency. These sometimes operate in the same direction as inductive effects and sometimes in the opposite direction. In many cases the overall result can be successfully predicted, as also can some unusual frequencies, such as the high carbonyl frequency of acetyl tetrazole (1790 cm^{-1}) or the low value of *N*-methyl-4-pyridone (1580).

Field effects operating across space also occur and lead to doubling of the carbonyl bands in compounds such as chloro-acetone. Rotational isomerism can usefully be studied in this way.

These ideas have a direct use, not only in enabling us to understand the basic principles underlying the use of group frequencies, but also in a direct manner in showing up interrelationships between two or more bands within the same spectrum, making recognition more certain.

Solvent Extraction of Inorganic Substances. On 27 November, a joint meeting was held at the University of Southampton with the Chemical Society and the University Chemical Society. Dr A. G. Maddock of the University of Cambridge spoke on 'Solvent Extraction of Inorganic Substances.' The lecturer dealt with the solvent extraction of polar inorganic substances by a variety of organic solvents.

After a general survey of the practical applications of this process, Dr Maddock developed the theoretical side of the problem, with particular reference to the nature of the extracted species and the part played by the solvent.

Social Evening. A Film Show and Sherry Party were held at the University of Southampton on 30 November. A most enjoyable evening was spent by the members, visitors and guests who attended.

Burgundian Wines of France. On 4 December a meeting was held jointly with the Portsmouth and District Chemical Society at the College of Technology, Portsmouth. The speaker was Professor Fraser Mackenzie of the University of Birmingham who spoke on 'The Burgundian Wines of France.' The lecture was a most fascinating account not only of Burgundian wines and their special characteristics but also of the history and social customs of Burgundy. Members were shown the correct method of drinking wine. The vote of thanks was proposed by Mr V. J. Pearcy.

Visit to Fawley. By courtesy of the Chief Chemist, a party of members and guests were shown over the chemical laboratories at the Esso Refinery, Fawley, on 9 December. After being entertained to tea the party went to the Esso Recreation Club, Holbury, where they were joined by more members and also by members of the Institute of Petroleum, for a lecture on 'Chemical Fertilizers in Agriculture' by Mr W. D. Carson of Fisons Ltd.

After an historical survey of the development of the synthetic fertilizer industry from its birth in the early nineteenth century to its present state today, the three major fertilizers—phosphates, potash and nitrogen—were each discussed in detail. The lecture was well illustrated with slides and after a discussion, a film, 'Wealth in the Drill,' showing the manufacture of one of Fisons' compound fertilizers, was screened. The vote of thanks was proposed by Dr D. F. Jacques, Vice-Chairman of the Fawley Branch of the Institute of Petroleum.

Valency Problems. On 14 January a meeting was held jointly with the Portsmouth and District Chemical Society at the College of Technology, Portsmouth, when Dr G. W. A. Fowles of the University of Southampton, spoke on 'Valency Problems in Inorganic Chemistry.'

The lecturer began with the development of the structure of the atom from the Bohr atom via wave mechanics and the Schrödinger equation to the now familiar concept of atomic orbitals.

The bending of such atomic orbitals to form molecular orbitals was discussed and the process of hybridization described with reference to beryllium, boron and carbon.

Dr Fowles described the structures of the ammonia and water molecules and the sp^3 hybridization of the nitrogen and oxygen orbitals. The structure of ozone was also discussed and the concept of the delocalized π-band introduced.

The part played by the *d* electrons in molecular structures was illustrated by reference to the structures of sulphur hexafluoride and sulphur trioxide.

The lecture ended with a description of equivalent orbitals, which account excellently for the structure of the boron hydrides. The equivalent orbital theory leads to the idea of 'bent bonds' in ethylene and a three-centre orbital in the boron hydrides.

After a discussion the vote of thanks was proposed by Dr J. L. Latham.

NEWCASTLE UPON TYNE AND NORTH-EAST COAST

Chemotherapeutic Research. On 25 November, 1959, Dr F. L. Rose, O.B.E., F.R.S., delivered a lecture to a well-attended meeting held jointly with the Chemical Society and Society of Chemical Industry at Sunderland Technical College; the Chairman was Dr J. O. Harris.

Dr Rose surveyed many synthetic drugs introduced during recent years, and illustrated how the empirical approach to a biologically active substance was still largely employed; rational principles are still imperfectly worked out. Although a naturally-occurring drug may have a complex structure, it is not always essential for a synthetic product to have the same degree of complexity in order to show similar activity. Dr Rose emphasized that the mechanism of drug action was not known completely, and that solubility is not always a criterion of effective activity.

After questions from the audience, the vote of thanks to the lecturer was proposed by Dr E. P. Hart and was carried with acclamation.

NORTH LANCASHIRE

Zone Refining. On 26 November, 1959, a meeting was held in Preston when Mr A. Muscott gave a lecture on 'Zone Refining.' (For an account of the method, see *Lect. R. Inst. Chem.*, 1957, No. 3.)

Having outlined the principles of zone refining, Mr Muscott mentioned modern apparatus for repeated floating-zone refinement of crystals of silicon of 7/8 in. diameter, which demands great attention to details of drive, specimen alignment and coupling of the R.F. heating coil.

Another apparatus in which electron bombardment is used as a concentrated source of heat, produces zone-melted single crystals up to 3/8 in. diameter of tungsten, rhenium, tantalum, molybdenum, rhodium, iridium, platinum, silicon and niobium and also zone-melts some insulators.

The main applications of zone melting have been in the field of semi-conductors where impurity levels of 10^{-9} and less have been achieved, but even this low level may exclude their use in some devices.

Zone refining is being increasingly applied to research problems in the physics of pure metals, including dislocations and super-conductivity, and in studies of organic phosphors for photomultipliers.

Mr W. G. Creasy proposed the vote of thanks.

SHEFFIELD, SOUTH YORKSHIRE AND NORTH MIDLANDS

Radioactive Tracers in Surface Studies and Metallography. On 27 October, 1959, at a joint meeting with the Sheffield Metallurgical Association, Dr G. T. Rogers of the Isotope Division, A.E.R.E., Harwell gave a lecture on the 'Uses of Tracers and Autoradiography in Surface Studies and Metallography.' Dr A. S. C. Lawrence was in the Chair.

Dr Rogers said that a radioactive tracer is essentially an analytical tool by which small quantities of an element can be detected and measured. Nuclear counting techniques are used to detect and measure the nuclear radiations emitted in the radioactive decay of a radio-tracer. The nature of the radio-element, that is a tracer, can be determined from the characteristics of these radiations and the amount of the radio-element from the intensities of the radiations.

Radioactive tracers are particularly useful for measuring how much of an element has been transferred from one chemical or physical state to another. The states are defined chemically, *e.g.* sulphur as a sulphate, or physically, *e.g.* iodine in chloroform in a water–chloroform–iodine system. These definitions do not distinguish between an element and a radio-isotope of that element, but the nuclear counting techniques do make this distinction. Therefore, in any tracer experiment, it is advisable initially to consider the inactive element and the radioactive isotope of that element as different, and later deliberately to equate the chemical and physical properties of isotopes. Such an approach will show how exchange reactions, which are not detectable in chemical reactions, may introduce ambiguity into the interpretation of the results of tracer experiments.

Many of the radioactive isotopes used as tracers are produced by bombarding the nuclei of inactive elements with neutrons in a nuclear reactor. The number of radioactive atoms produced per second equals $n\sigma f$, where n is the number of target nuclei irradiated, f is the flux of neutrons/cm^2 sec and σ is the cross-section for the nuclear reaction involved. In a nuclear reaction, σ corresponds to the specific rate constant in a chemical reaction and has a different value for each nuclear mass number. Values of σ are not in any way related to the familiar chemical and physical properties of the elements. Therefore, when a chemically pure material is irradiated with neutrons a number of radioactive isotopes are generally produced. For example, irradiation of zirconium containing 0·6 per cent hafnium will give equal radioactivities of ^{95}Zr and ^{175}Hf. Radio-tracers must be radiochemically and chemically pure for most applications.

A nucleus which has captured a neutron is in a metastable state. The nucleus loses energy by the emission of fast-moving electrons (β-particles), and electromagnetic radiations (X-rays and γ-rays). The rate of decay is given by

$$\frac{dn}{dt} = -\lambda n \qquad \lambda = \frac{\ln 2}{t_{\frac{1}{2}}}$$

where $t_{\frac{1}{2}}$ is the half-life of the radio-element. A radio-element can be identified from a suitable combination of measurements of half life and the natures and energies of the radiations emitted. Hence these measurements serve to establish radiochemical purity. Counting methods generally give only the amount of radio-isotope present in a volume of material. Autoradiography can show the spatial distribution on a microscopic scale of a radio-tracer in a material such as a metallic alloy. The technique consists of placing a thin section of the material containing a radio-tracer in close contact with a fine-grain photographic emulsion. The image formed by the radiation from the tracer will then show how

the radiation is distributed in the alloy. This distribution can then be compared with a micrograph of the specimen. Autoradiographs showing the distribution of 0·2 per cent chromium in a complex Al–Mg–Zn alloy illustrated this technique. An investigation into the behaviour of thiourea in producing brightening and levelling of electrodeposited nickel using ^{35}S-labelled thiourea was described and taken to illustrate important features in the use of tracers. Radio-tracers are useful as analytical tools for the determination and location of small amounts of an element. For the majority of tracer experiments a radio-element must be chemically and radiochemically pure and its state of chemical combination known. The normal arguments from chemical and physical principles must be used in conjunction with radio-tracer measurements to interpret results.

Many members joined in the discussion after the lecture and in his replies Dr Rogers mentioned several more interesting examples of the use of isotopes in problems being investigated by chemists and metallurgists. The vote of thanks was proposed by Professor A. G. Quarrell.

TEES-SIDE

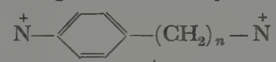
Visit to Steetley Magnesite Co. The Autumn Programme began with a visit to the Steetley Magnesite Company's Works at Hartlepool on 16 September, 1959. The party, accompanied by the works manager, saw the plant used for extracting magnesia from sea water. Dolomite, containing equimolecular proportions of calcium and magnesium carbonates is calcined, slaked, and used to precipitate magnesium as the hydroxide. In this way the size of the precipitating and settling sections of the plant is only half that required for calcium oxide alone since half the magnesia is derived from dolomite. The vast quantities of sea water containing 0·5 per cent magnesium chloride are treated to remove temporary hardness before precipitating the salts of magnesium as the hydroxide. The magnesium hydroxide is filtered from a concentrated slurry obtained from settling tanks and calcined to magnesia. Traces of sodium chloride are removed by volatilization in the final stages of calcining. The product is largely used as a refractory.

Pharmacology of Polymethylenes. On 28 September a meeting was held in Middlesbrough when Dr H. R. Ing gave a lecture on 'The Pharmacology of Polymethylenes.'

Dr Ing stated that therapeutic science was essentially chemical in nature and was at present in its infancy. The action of the vast number of drugs now used could not, as yet, be understood in a general way, and the lecture would be limited to difunctional polymethylene compounds of the general type $X(CH_2)_nY$. This type of compund is used for treating tropical diseases, for example sleeping sickness. Is the value of n important from the point of view of the drugs' activity? A similar problem has been found in enzymology. Here enzymic oxidation of polymethylene diamines has been shown to depend on the number of methylene groups between the amino functions.

Neuromuscular blocking agents, for example curare alkaloids, paralyse the voluntary muscles of animals. They act on the nerve muscle junctions and prevent the normal liberation of acetyl choline in the muscle caused by a nerve impulse. In the late 1930s there was interest in neuromuscular blocking agents as means of giving complete muscular relaxation. The structure of one of the curare alkaloids was elucidated and as a result a large number of compounds of the methonium type, $(CH_3)_3\overset{+}{N}(CH_2)_n\overset{+}{N}(CH_3)_3$, were tested for activity as neuromuscular blocking agents. A few active ones were found. Later it was shown that the lower members (n = 4 to 7) blocked the nerve ganglion cell. The most active was hexamethonium, used in the treatment of high blood pressure.

Following this work compounds of types

 and

$$\overset{+}{N}-(CH_2)_n-X-(CH_2)_m\overset{+}{N}$$

(X = O, S, N·CH_3) were tested. These showed the importance of chain-length.

Schuelar pointed out that molecules were flexible, and the chief interest is in probability distribution as far as lengths between groups are concerned. Calculation showed that only for three-linked systems could the variations in length be defined. From the results it was concluded that 6–7·8Å was the required distance between the groups. This was most likely with a five-membered polymethylene carbon chain.

Annual General Meeting. The Section's A.G.M. was held on 14 October. The Hon. Secretary's and Hon. Treasurer's Reports were accepted. The following Officers and Members of Committee were elected for 1959–60: Chairman, Dr I. J. Faulkner; Vice-Chairman, Dr D. G. Jones; Hon. Treasurer, Dr A. A. L. Challis; Hon. Secretary, Dr G. H. Mansfield; Members of Committee: Drs G. P. Dick, L. C. Dick, V. Moss, P. Smith and D. A. Spratt and Messrs W. T. Cresswell, R. Green and W. C. J. Smith.

Chemistry of the Less Common Elements. A joint meeting with local members of the Society of Chemical Industry was held on 2 November at Norton when Professor R. S. Nyholm, F.R.S., gave a lecture on 'Recent Developments in the Chemistry of the Less Common Elements.'

Professor Nyholm reviewed the discovery of some elements which had only recently been isolated. Some of these, for example francium, could not easily be studied because of their short lives. The lecture was limited to the chemistry of technetium, rhenium and related compounds.

Although technetium was formed in 1937 by the bombardment of molybdenum with deuterons it has

only become available in gram quantities recently in waste liquors from atomic piles. The chief difficulty is to isolate it from this strongly radioactive material.

Manganese, technetium and rhenium are able to exist in the oxidation states of 7 to -1, and the lecturer gave an account of the compounds which had been prepared. In the case of technetium only compounds of the oxidation states 7, 4, 3 and 2 have as yet been obtained.

The vote of thanks was proposed by Mr G. R. Nellist.

Visit to Fishburn Colliery. On 18 November a party visited Fishburn Colliery and was taken on a tour of the pit by the colliery manager. Modern methods of coal mining were seen and followed from coal face to pit head.

Exhibition of Films. On 9 December in Stockton the annual exhibition of films was held. The films included 'Hide to Sole,' 'Triple Action,' 'Royal Doulton' and 'The Frasch Process.' The films were of general interest and were enjoyed by the members and guests present.

THAMES VALLEY

Ladies' Evening. A meeting of the Section, with Dr D. T. Lewis in the Chair, was held in Heelas's Restaurant, Reading, on 15 January and took the form of a Ladies' Evening.

The meeting was addressed by Mr G. Osgood who spoke on 'Wines and the Application of Chemistry to their Production."

After the talk, which was illustrated with a number of excellent slides, many of which were in colour, the audience was invited to do a little practical work. Six wines, all produced within an area of 4 square miles, were subjected to test. Although members were unable to ascertain accurately the rH, pH, Cu or Fe values, they were fully appreciative of flavour and bouquet.

The thanks of the audience were expressed by Dr P. F. Holt.

DECCAN

Molecular Structure and Chemical Binding. At a meeting held on 11 December, 1959, in the General Chemistry Lecture Hall of the Indian Institute of Science, Bangalore, Dr C. N. Ramachandra Rao, of the Department of Inorganic and Physical Chemistry, Indian Institute of Science, delivered a lecture on 'Recent Investigations of Molecular Structure and their Impact on the Theories of Chemical Binding.' Professor M. R. Aswathanarayana Rao was in the Chair.

The advances made in recent years in experimental and theoretical methods in the study of structural chemistry have been possible largely by the application of spectroscopy and diffraction. Nuclear and paramagnetic resonance spectroscopy, high-temperature mass spectrometry and low-temperature matrix isolation of reactive species are some of the more recent techniques. The bond distances obtained by electron diffraction are now reported with uncertainties only of the order of 0·005 Å. Because of the reliability and accuracy of the structural information it is possible to propose, with more confidence, theories or explanations of chemical binding.

The determination of the molecular structures of, for example, proteins, penicillin and boron hydrides, has been indeed a great achievement in structural chemistry during the past decade. Of late it has been possible, with the aid of electron diffraction or microwave spectroscopy, to study the C–C bonds with different hybridizations, the double bond character of C–Cl bonds in chloroethenes, the adjacent charge rule, the effect of multiple bonds on adjacent C–C, C–H and C–halogen bonds, the evidence for hyperconjugation based on bond distances, and conformation analysis.

Recently the thermodynamics of the large molecules in carbon vapour have been predicted by theory, and the presence of C_5 has already been verified experimentally. Reactive species, like CH_2 and NH_2, have been studied by trapping them in inert matrices at low temperatures. Electron spin resonance and microwave spectroscopy have also been usefully employed in the study of free radicals. In the light of these and other developments, it is reasonable to hope that the study of the structural properties of the excited and transition states of molecules, in addition to their ground states, will prove most fruitful in the future.

After a valuable discussion Dr S. C. Pillai proposed the vote of thanks.

NATO SCIENCE RESEARCH GRANTS

The North Atlantic Council has established a fund ($500,000 for the first year) to give grants for research projects in the field of natural sciences and technology. The grants are primarily for promoting increased co-operation in research among the member nations and to a lesser extent for other scientific projects where international aid is particularly desirable.

Grants will be made for preparatory work which might lead to large co-operative projects and for smaller co-operative projects. Some grants will be made to stimulate research in the less-developed member countries.

The selection of the recipients of the research grants will be made by a Scientific Research Grants Panel consisting of five distinguished scientists.

The results of research encouraged under this programme will be made available for the benefit of all member countries.

Applications should be made to the Office of the Science Adviser, North Atlantic Treaty Organization, Palais de Chaillot, Paris XVI^e, France.

News and Notes

SCHOLARSHIPS AND AWARDS

Corday-Morgan Medal and Prize.—This Award, consisting of a Silver Medal and a monetary Prize of 200 Guineas, is made annually to the chemist of either sex and of British Nationality who, in the judgment of the Council of the Chemical Society, has published during the year in question the most meritorious contribution to experimental chemistry, and who has not, at the date of publication, attained the age of 36 years.

Copies of the rules governing the Award may be obtained from the General Secretary, The Chemical Society, Burlington House, London, W.1. Applications or recommendations in respect of the Award for the year 1959 must be received not later than 31 December, 1960, and applications for the Award for 1960 are due before the end of 1961.

D.S.I.R. Awards.—Further information on D.S.I.R. awards are contained in two recent publications available from H.M.S.O. They are *D.S.I.R. Studentships and Fellowships*, price 1s. 6d. net, and *D.S.I.R. Research Grants*, price 1s. 3d. net.

The Department of Scientific and Industrial Research is now supporting nearly twice as many postgraduate students in science and technology compared with 3 years ago. The actual number of research students receiving D.S.I.R. studentships this year is 2,143. In addition 271 are holding advanced course studentships, and 48 have research fellowships. Some of these awards are tenable abroad.

Scholarships Abroad 1960/61.—Scholarships for the academic year 1960–61 are offered to British students by governments and universities in the following countries: Austria, Belgium, Brazil, Denmark, Finland, France, Germany, Iceland, Indonesia, Iran, Israel, Italy, Japan, The Netherlands, Norway, Poland, Portugal, Spain, Sweden, Switzerland, United States of America, Yugoslavia. Full particulars are given in a recent British Council booklet *Scholarships Abroad* 1960–61. Application forms and booklets may be obtained from the British Council, 65 Davies Street, London, W.1, or from any British Council Office in the U.K.

EDUCATIONAL

Crystal Structure Determination.—A summer school in Modern Methods of Crystal Structure will be held in the Manchester College of Science and Technology from 29 August to 9 September. Many distinguished crystallographers will be among the lecturers. The fee for the course, with accommodation, will be £25; without accommodation, £5. Further details and a form of application may be obtained from the Director, Extra-Mural Department, The University, Manchester.

Special grants are available to members from NATO countries and enquiries should be addressed to Professor H. Lipson, Physics Department, College of Science and Technology, Manchester 1.

Monash University.—First appointments to the staff of the new Monash University in Victoria, Australia, have recently been announced. Dr A. J. Marshall of St Bartholomew's Hospital Medical College, London, has been appointed Professor of Biology; Dr R. D. Brown, Melbourne University, Professor of Chemistry; Mr E. H. Clarke of the University of Malaya, Librarian; and Mr F. H. Johnson, the University of Western Australia, Registrar. Professor J. A. L. Matheson, formerly of the University of Manchester, will be Vice-Chancellor.

Sandwich Courses in Chemistry.—The following addendum is intended to complete the information on Sandwich Courses in Chemistry and Applied Chemistry given in December (*J.*, 1959, 726).

The course at the Royal College of Science and Technology, Glasgow, leading to the award of the A.R.C.S.T. will afford exemption from the Graduate Membership Examination if the final qualification is obtained with 1st or 2nd class honours.

The Sandwich Course at Whitehaven College of Further Education prepares candidates for Part I as well as Part II of the Graduate Membership Examination.

MEETINGS AND SYMPOSIA

Analytical Chemistry and Agriculture.—A symposium organized by the Midlands Section of the Society for Analytical Chemistry on 'Analytical Chemistry in the Service of Agriculture,' will be held at the University of Nottingham on 14–15 July. The fee for the symposium will be three guineas. Registration forms and further information may be obtained from C. A. Johnson, Standards Department, Boots Pure Drug Co. Ltd, Station Street, Nottingham.

Combustion Research.—The last three Colloquia arranged on this subject by the department of chemical engineering, Imperial College of Science and Technology. will take place on 29 February, and 14 and 21 March. They will be given by W. S. Affleck on 'The study of burner-stabilized coal-dust flames'; by N. H. Pratt on 'Some aspects of kinetic studies in high-temperature flow régime, with particular reference to methane oxidation'; and by G. W. K. Wainwright on 'Atmospheric pollution in Hyde Park.' The colloquia will be held in Room 105 of the College at 3.45 p.m. Visitors are welcome and further details may be obtained from the Department of Chemical Engineering.

Gas Chromatography.—The Third Gas Chromatography Symposium, organized by the Society for Analytical Chemistry and the Gas Chromatography Discussion Group under the auspices of the Hydrocarbon

Research Group of the Institute of Petroleum, will take place in Edinburgh from 8 to 10 June. The symposium will include scientific papers and discussions, an exhibition of commercial equipment, visits to local industries and social functions. The papers to be presented will be divided under the three headings: apparatus and technique; theory and application; and general applications. There will be a registration fee of £5 (£6 for Canada and the U.S.A.) which will entitle delegates to receive preprints of the papers and to attend all social functions. The whole of the proceedings will later be published in book form. Further particulars and registration forms may be obtained from the Assistant Secretary, Society for Analytical Chemistry, 14 Belgrave Square, London, S.W.1.

Metallic Corrosion.—The First International Congress on Metallic Corrosion will be held at the Imperial College of Science and Technology, London, from 10 to 15 April, 1961. The scientific programme is being organized by a special committee under the chairmanship of Mr L. Kenworthy, Chairman of the Corrosion Group of the Society of Chemical Industry. A provisional programme and application form may be obtained from the Hon. Secretary of the Congress, 14 Belgrave Square, S.W.1.

Oil and Colour Chemists' Association.—As already announced (*J.*, 1959, 599) the Twelfth Technical Exhibition will take place on 15–17 March at the Royal Horticultural Society's New Hall, Greycoat and Elverston Streets, London, S.W.1. The opening ceremony will be performed by Sir Alexander Todd, F.R.S., at 3 p.m. on 15 March after the Exhibition Luncheon, which will take place at the Criterion Restaurant, Piccadilly. All enquiries should be made to R. H. Hamblin, Wax Chandlers' Hall, Gresham Street, E.C.2.

S.C.I. Symposium.—The Plastics and Polymer Group of the Society of Chemical Industry is arranging a three-day symposium on 'High-Temperature Resistance and Thermal Degradation of Polymers' to be held at the William Beveridge Hall, Senate House, University of London, on 21–23 September. A provisional programme and further particulars may be obtained from the Convener, Plastics & Polymer Group, Symposium Sub-Committee, 14 Belgrave Square, S.W.1.

Reactivity of Solids.—The Fourth International Symposium on the Reactivity of Solids will take place in Amsterdam, at the Royal Tropical Institute, from 30 May to 4 June. The symposium will be divided into three main sections, each of which will be introduced by a plenary lecture, to be given by Dr F. S. Stone of Bristol on 'Mechanism and kinetics of reaction of solids'; Professor J. Bernard of Paris on 'Factors influencing reactivity'; and Professor C. Zwikker of Eindhoven on 'Technical application of reactivity studies.' Introductory lectures will also be given by speakers from the U.S.A., U.K. and Belgium, including Professor A. R. Ubbelohde. The programme will also include social events and excursions. Further details and forms of registration may be obtained from Ir G. van Gijn, Secretary, 4th International Symposium on Reactivity of Solids, Technische Hogeschool Eindhoven, The Netherlands.

Society for Water Treatment and Examination.—The Society's Annual General Meeting will take place in the Library of the Royal Society of Health on 11 March at 9.30 p.m. A symposium on 'Pollution of surface water supplies' will be held after the business meeting.

Further particulars can be obtained from A. W. H. McCanlis, 41 Carshalton Road, Sutton, Surrey.

S.M.A. ANNUAL MEETING

Science teachers from many parts of the United Kingdom gathered for the Annual Meeting of the Science Masters' Association, which was held in the University of Southampton from 29 December to 1 January.

The programme included lectures and demonstrations, visits, discussions, films, and, in addition to the usual Members', Manufacturers' and Publishers' exhibitions, a number of special exhibitions which attracted considerable interest.

Lectures that were of particular interest to chemists were given by Dr G. W. A. Fowles, on 'Directed valency,' and by Dr H. M. Frey on 'Reactions of "hot" molecules.' Many of the chemistry teachers present also found profit and pleasure in lectures on other branches of science, notably Professor A. M. Taylor's 'Demonstrations in Light and Colour' which filled the Physics Lecture Theatre on two successive mornings, lectures on aeronautics, electronic and nuclear engineering, and Dr Hecht's impressive demonstrations of the work done in atomic physics in West German schools.

A most interesting programme had been arranged for afternoon visits to industrial establishments, university departments and places of general interest such as Winchester College, Southampton Docks, the Union Castle Liner 'Winchester Castle' and H.M.S. 'Collingwood'. Among the firms visited were the Esso Petroleum Co. Ltd, International Synthetic Rubber Co. Ltd and the British Drug Houses establishment at Poole.

The traditional exhibitions were well supported; the sixty manufacturing firms represented had put on a fine display and reported exceptionally keen interest in their products, while there was a steady stream of members to see the excellent Publishers' stands (at which the Institute was represented), in the pleasant setting of the Lanchester Engineering Building.

An important feature of the meeting was the special exhibition on 'Atomic and Molecular Structure and Nuclear Energy,' with some fine displays on this theme

by firms and organizations in the U.K., U.S.A. and West Germany. These included a student reactor, reactor simulator and monitoring equipment, and many pieces of apparatus and teaching aids which would be valuable to schools, technical institutions and universities. Other special exhibitions included visual aids, a feature display on textile research, and apparatus contributed by teachers in secondary modern schools.

During the meeting simultaneous discussions took place on draft syllabuses in physics, chemistry and biology, prepared by subject panels set up by the Association to implement the policy statement, 'Science and Education,' which was published in 1957. At the Annual Business Meeting the Chairman stressed the need for a permanent headquarters for the Association, in view of the rapid expansion of its membership and activities, and outlined proposals for a Science Education Centre, to be set up immediately by the Association with the object of centralizing information about science education and avoiding wastage of personal and financial resources through unnecessary duplication of effort. This Centre will be located temporarily at Holt, in Norfolk, but it is hoped that sufficient help, financial and otherwise, will be put at the disposal of the Association by interested bodies to enable this important centre to be housed in a less remote spot in the near future.

The President for the coming year is Lord Boyd-Orr, and the Chairman is Mr E. W. Moore, A.R.I.C. (King's Norton Grammar School for Boys, Birmingham).

ASSOCIATION OF WOMEN SCIENCE TEACHERS

The Annual Conference of the Association was held in the Lecture Theatre of the Science Museum, South Kensington, on 1 and 2 January, 1960.

On the Friday evening the President, Miss M. Going, introduced Mr Maxwell Knight who gave a most interesting lecture, illustrated with slides, on 'Owls and their Prey.' Miss D. M. Scott proposed the vote of thanks.

On 2 January the Annual General Meeting was held at which reports on the Science Teachers' Joint Subcommittee, the Examinations Committee and the Aural and Visual Aids to Education Committee were given. There were also reports from representatives of other Committees on the activities of the Education Committee of The Royal Institute of Chemistry (Miss D. M. Kett), the Chemistry Sub-committee of the University of London Schools Examination Council, the Council for the Promotion of Field Studies, the S.M.A. Sub-committee for the training of science teachers and the Committee enquiring into the suitability of G.C.E. 'A' level Science syllabuses for entry into first-degree courses.

At the conclusion of the business meeting a presentation was made to the former secretary, Miss L. E. Higson.

Dr J. A. Harrison of the Educational Foundation for Visual Aids then showed three films: 'Photo-emission,' 'The Sea-shore' and 'Isotopes.'

In the afternoon the Conference was resumed and was devoted to a symposium on 'The training of the Science Teacher.' Papers were presented on 'The Primary School,' 'The present two-year course and the future three-year course for teachers in the Secondary Modern School,' 'Returning to College after teaching to do a one-year course,' 'The post-graduate course for the Grammar School' and 'The trainee in school.' The papers were followed by a general discussion.

SCIENCE IN PARLIAMENT

CHEMICALS AND FOOD

Recently several questions have been asked in Parliament on the effects, to both men and animals, of spraying crops with chemicals.

On 12 November Mr Dodds asked the Minister of Agriculture, Fisheries and Food if he was aware of the concern arising from the widespread destruction of bees by the increasing use of chemical sprays; what consideration had been given to the matter; and what action by his Department was contemplated.

The Minister (Mr J. Hare) replied that there had been concern caused by serious losses of bees last June, but this had been due to abnormal weather conditions. He considered that the best way of meeting the problem was by co-operation between farmers, spraying contractors and beekeepers, and by continued education and advice.

On 19 November, a question was asked on what study was being undertaken on the cumulative effects of the unrestricted use of chemicals in agriculture. Mr J. B. Godber replied that three units of the Medical Research Council were engaged on research into the effects, both acute and cumulative, on human health, and some of their findings had been published. The Agricultural Research Council and the Nature Conservancy have been studying the effects on animals and plants and on wild life generally.

On 20 November the possibility of setting up a commission of enquiry to look into the whole question of the use of toxic sprays was put forward. Mr Godber said that a scheme, suggested by the Zuckerman Working Party Report on Residues of Toxic Chemicals in Food, was brought into being in 1954, whereby the Government and the agricultural chemical industry worked together to examine the proposed use of new toxic substances or new uses of existing chemicals. Its Advisory Committee considered risks to operator, consumer, farm animals and wild life.

Answering questions on the carcinogenic effects of some chemicals, banned in the U.S.A., Mr Walker-Smith said that none had made its way to the British market. Later, he also answered a question on the possibility of DDT causing leukaemia, aplastic anaemia,

jaundice and the like, by saying that there was no evidence that blood disorders can be produced by DDT.

On 24 November, 1959, the use of aminotriazole was discussed and Earl Waldegrave, the Joint Parliamentary Secretary, Ministry of Agriculture, Fisheries and Food, said that in this country it was employed as a herbicide and was not recommended for use on growing crops. He added that there was no evidence that it is a cancer-inducing agent and, although there could be no guarantee that it would not accidentally get on to crops used for human consumption, it was not likely to cause injury to humans. As it is of such low mammalian toxicity, examination by the Advisory Committee on Poisonous Substances was not necessary.

Mr de Freitas asked Mr Hare, as representing the Minister for Science, on 4 December, what report he has received from the Therapeutic Substances Testing Board of the Agricultural Research Council about a drug which would cure or prevent fowl pest.

Mr Hare replied that the attention of the Veterinary Therapeutic Testing Board had been drawn to a substance marketed under the name of HEL-A-MIN 100 for the treatment of fowl pest. The manufacturers had been asked to supply certain information which would enable the Board to determine whether there was a case for testing this product.

ATMOSPHERIC POLLUTION

On 23 November Mr Darling asked the Minister of Health, as representing the Minister for Science, whether he would discuss with the Medical Research Council the urgent need for a study of the effects on health of sulphur and other gases emitted from oil-fired boilers and furnaces and from exhausts of mobile and stationary oil engines.

Mr Walker-Smith replied that the Medical Research Council was already investigating the effects on health of atmospheric pollution from sulphur compounds and other gases produced by the combustion of various fuels, including oil. Although these were potentially harmful, experiments had not so far demonstrated any ill-effects from exposure to any level of concentration in the atmosphere to which human beings were, in practice, exposed.

On 7 December Mr Sorensen asked the Minister of Health, as representing the Minister for Science, what progress had been made in his inquiry into the effect of fumes and exhaust from diesel-driven vehicles; and to what extent he had consulted the Minister of Transport on the need to reduce this nuisance and danger to health.

Mr Walker-Smith said that the Medical Research Council was actively engaged in research into the effect of diesel fumes on health. These investigations had so far demonstrated no immediate or long-term deleterious effects from this source. The Minister of Transport was in consultation with the Department of Scientific and Industrial Research on the measurement and mitigation of this nuisance.

Mr Nabarro asked the Minister of Education, as representing the Minister for Science, what progress had been made by the D.S.I.R. in connection with the muffler device of a filtration character brought from the U.S.A. for experimental purposes, in connection with abatement of noxious fumes from the exhausts of motor vehicles, notably diesel oil vehicles; when a report upon the efficacy of this equipment would be available; and, having regard to the vitiating effect of exhaust fumes upon the promotion of clean air policy, what further steps would be undertaken in connection with the decontamination and decolorization of exhaust fumes.

Sir David Eccles replied that the American device was not in commercial production and had not yet reached the stage of development at which the claims of the manufacturers could be assessed by the Warren Spring Laboratory. The laboratory was, however, keeping in touch with this development, and arrangements were being made to test two other devices recently developed in the U.K. and Switzerland.

FUEL AND POWER

Mr Hamilton asked the Minister of Power on 2 November if he would make an interim statement on the progress of the investigation into the by-product potentialities of coal; and whether he would consider the publication of periodical reports of the progress made.

Mr Wood replied that the Committee was appointed in April, 1959, and was pressing on urgently with its very detailed investigations.

He did not want to delay the Committee's final report by asking for progress reports about the main subject of its inquiry.

On 14 December Mr Pentland asked the Minister of Power whether he was aware that the Wilson Committee had now reached a stage where it would welcome further written memoranda from people interested in research and development on processes making chemicals, gases and oil from coal, and that the delays caused by their procedure had caused public concern; and, as it was an urgent national need that new uses were found for coal, if he would give the Committee power to secure immediate information on all research, known and potential, into the scientific exploitation of Great Britain's coal reserves.

In reply Mr Wood said that the Chairman had told him that the Committee had already received a large amount of information and had had the fullest co-operation from all the organizations approached. The Committee did not require special powers to obtain information, and its latest request was intended to make sure that anybody who wished to help was given the opportunity to do so.

Mr Wyatt asked the Minister of Power on 30 November the amount spent annually on research into the uses of coal, as distinct from coal-winning methods; how this research was co-ordinated; and what steps were being

taken to increase the amount spent on research in this field by the various nationalized industries for which he was responsible.

Mr Wood replied that the Government, the nationalized industries and the research associations were spending about £1·6 million a year on research, as well as increasing amounts on the development of new processes. It was his responsibility to co-ordinate these research programmes and in doing so, he had the advice of his Scientific Advisory Council under the Chairmanship of Sir Alexander Fleck.

He had no figures for research expenditure by private firms and knew of no promising field of investigation which was being neglected for lack of funds; but it was possible that the report of the Wilson Committee on Coal Derivatives might suggest directions in which the research could usefully be intensified.

RADIOACTIVITY

On 17 December Mrs Butler asked the Minister of Health, as representing the Minister for Science, what was the date on which particles of sufficient radioactivity to kill living cells which come into direct contact with them were first discovered in the fall-out in Great Britain by scientists advising the Government; and what was the size and date of discovery of the largest particle thus observed.

Mr Walker-Smith replied that all radioactive particles, whether arising from natural sources or from nuclear tests, were capable in appropriate circumstances of inducing lethal damage to human cells. Particles of measurable size had been detected in fall-out since 1950. Studies had been made in the past of the sizes of particles arising from nuclear tests, but it was the total radioactivity from this source which was considered to be of main significance for human health and this was what was now regularly measured.

MINISTER FOR SCIENCE

The Prime Minister, on being asked which departments would come under the guidance of the Lord Privy Seal (Viscount Hailsham) in his new role of Minister for Science, replied that he would be responsible to Parliament for the Council for Scientific and Industrial Research, the Medical Research Council, the Agricultural Research Council, the Overseas Research Council and the Nature Conservancy and would be chairman of the five Privy Council Committees to which they report.

On 7 December the Financial Secretary to the Treasury, Sir Edward Boyle, referred briefly to the Advisory Council on Scientific Policy, the present Chairman of which is Sir Alexander Todd, and the Deputy Chairman and Chairman of the Committee on Scientific Manpower, Sir Solly Zuckerman, recently appointed Scientific Adviser to the Minister of Defence. Sir Edward said that the Minister for Science had already asked the Advisory Council to advise him on the balance of our national scientific effort, to assist in the detection of gaps in our activities.

The Minister for Science, said Sir Edward, would be occupied full-time and would attach great importance to the links between the establishment of the Research Councils on the one hand and the universities and technical colleges on the other, and it would be his aim to make these links and the relationship as fruitful as possible.

The Minister would also have close contacts with the Minister of Aviation, as he would be directly responsible for space research. The Minister of Education, Sir David Eccles, said that the Government's responsibility in the field of science could be divided into two parts. First, the supply of scientific manpower, and secondly, how best to use the trained manpower and material resources we have available.

OCEANOGRAPHY

On 4 December Mr D. Price asked the Civil Lord of the Admiralty how many oceanographers from Great Britain participated in the International Congress on Oceanography, which met in New York from 31 August to 11 September; and what recommendations it had produced.

Sir Edward Boyle replied that 25 persons from Government Departments and from scientific institutions in the U.K. which received grants from the Exchequer are known to have attended this Congress. He understood that its primary purpose was the exchange of information and that no recommendations were made.

SCIENCE IN CIVIL LIFE

In the House of Lords on 9 December, Lord Taylor asked the Government to state its plans for the development of science in relation to industry, agriculture, medicine and social needs. He urged the establishment of a Social Science Research Council, so that scientific method might make its own contribution to the welfare of mankind.

The Minister for Science, replying, referred to space research and the proton synchroton which was being built by the Atomic Energy Authority. He pointed out that the future of our scientific effort depended very largely upon the universities and colleges of advanced technology.

The Minister said that the main challenge was the relationship between Government and science and technology, in all its aspects. It would be necessary to discover how to get the best use from our science and technology by fitting the administration of it into our Parliamentary and democratic system. A greater degree of scientific literacy for the future would have to be encouraged in our educational system. He added that it was clear we could get no adequate use or deployment of qualified scientific manpower, of the

scientific graduate, 'or of the graduate technician,' unless there was a vast army of technicians to support their work.

Lord Morrison of Lambeth said that it was a good thing for Parliament to take an interest in science. He thought that the industrial research organizations could be valuable to the trade union movement as well as to the employers.

Lord Hailsham, speaking on the question of the social sciences, said that a great deal of research was going on. He did not thing that because the social sciences needed encouragement a Social Research Council was the right organization to do it.

National Society for Clean Air.—Orders are now being taken for the final volume of the *Proceedings* of the Diamond Jubilee International Clean Air Conference, which in addition to the 78 papers presented, will also include the Vice-President's Address, the sessional reviews by the rapporteurs, and a full record of the discussions and replies from the authors. (Abstracts of the papers are in the winter issue of *Smokeless Air.*)

The volume will be an up-to-date survey of air pollution problems and should prove an invaluable work of reference. It will be published in book form, with a full cloth-covered hard binding, in the spring.

The price will be 30s. per copy, plus 2s. 6d. to cover packing and postage or carriage. Early ordering is advised as the number of copies to be printed will depend on the demand. Enquiries should be addressed to the National Society for Clean Air, Palace Chambers, Bridge Street, London, S.W.1.

Factories Act 1959.—A memorandum sent out by the Ministry of Labour in connection with the Factories Act 1959, which was brought into force at the beginning of last December and became operative on 1 February, explains that compliance with some sections may necessitate alterations to buildings, plant and equipment. Under 'Dangerous Substances,' additional precautions are required for the protection of personnel where corrosive or poisonous substances are in use. There are also additional provisions in connection with safe means of access and safe places of employment. No person must be expected to work in an area where he is liable to fall more than 6 feet 6 inches or where there are likely to be dangerous fumes or a shortage of oxygen.

The section on Explosive Dusts requires the prevention or removal of accumulations of dust where there is a consequent danger of explosion.

The lifting of excessive weights is now prohibited to any person of whatever age. Another section deals with the hours of employment of women and young persons.

Plastics Industry Education Fund.—The Trustees of the Fund have awarded training grants to 18 students following full-time courses, and, in addition, have either granted or renewed ten scholarships of £150 each for the Diploma in Technology sandwich courses at the Borough Polytechnic and the College of Advanced Technology, Birmingham, and five of £175 each at the Brunel College of Technology. They have also granted or renewed three scholarships of £300 each for the Associateship of the Plastics Institute at the National College of Rubber Technology and three at £100 each for the Diploma of the Plastics Institute at the Borough Polytechnic. Further details may be obtained from the Plastics Institute, 6 Mandeville Place, London, W.1.

Polarographic Society.—Mr W. J. Parker has resigned his position as Secretary of the Society. Mr J. H. Glover has been co-opted as Secretary and all communications, including subscriptions, should be sent to him at 75 Craven Gardens, Wimbledon, S.W.19.

Society for Visiting Scientists.—In their Report on behalf of the Council to the 12th General Meeting held on 31 December, 1959, the Secretaries of the Society look back 15 years to the early hopes and plans at its inception. Not all have been realized, but the general picture is one of achievement and, although lack of funds has at times had a restrictive effect, this has never been allowed to cripple activities.

In the past year three discussion meetings were held: 'New light on vision'; 'As others see us'; and 'Food processing.' Three receptions were also held, arranged in honour of distinguished visitors.

Lectures were again arranged by the Overseas Science Students Association, which has its headquarters at the Society's House, and visits were made by the Association to the G.P.O. Long Distance Telephone Exchange, the Royal Festival Hall and the Houses of Parliament.

Stress is again laid on the need to obtain further financial support from industry and other sources.

Visitors to the U.K.

Australia. Dr F. J. R. Hird, Reader in Agricultural Biochemistry, University of Melbourne, has arrived in this country. His chief interests are fatty-acid metabolism in sheep and wheat proteins.

Canada. Dr G. Herzberg, Division of Pure Physics, National Research Council, has been lecturing at the Universities of Liége and Oxford and will receive an honorary degree at Oxford on 27 February.

South Africa. Mr J. G. Theron, Assistant Technical Officer, South African Bureau of Standards, will be in the U.K. until August at the British Petroleum Co. Ltd.

Among visitors who will be in this country from 24 March to 2 April are: P. B. Hagen, University Manitoba; S. Udenfriend, National Institutes of Healt Bethesda; L. Lundholm, University of Göteborg; R. F. Furchgott, State University of New York; T. L. Chrusciel, Silesian School of Medicine, Zabrze, Poland; U. von Euler, Karolinska Institutet, Stockholm; E. J. Ariens, Pharmacological Institute, Nijmegen, The

Netherlands; H. J. Schumann, Pharmakologisches nstitut der Universität, Frankfurt; and B. Belliau, Jniversity of Ottawa. Those who will be in the U.K. luring April include: O. Maaløe, University of Copen-nagen (10–16 April); L. Alföldi, Medical University of Szeged, Hungary (10–16); F. Jacob, Institut Pasteur, Paris, (10–17); A. Garen, Massachusetts Institute of Technology (11–15); and A. Gierer, Max-Planck-Institut für Virusforschung, Tübingen (11–16).

THE REGISTER

NEW FELLOWS

OD) Cama, Homi Ratansha, B.A., M.SC. (BOM.), PH.D. (LIV.)
N) Dakin, Harold Percy, M.SC. (MANC.), DIP.ED.
OD) Ganguly, Jagannath, M.SC.(DACCA), PH.D.(R'DG)
OD) Zaheer, Syed Husain, M.A. (OXON.), DR. PHIL. NAT. (HEIDELBERG)

ASSOCIATES ELECTED TO THE FELLOWSHIP

N) Butler, Clifford George, B.PHARM.(LOND.), M.P.S.
P) Casy, Alan Frederick, B.SC., PH.D. (LOND.), F.P.S.
P) Cavalla, John Frederick, B.SC., PH.D.(LOND.)
R) Collins, Dennis James, B.SC., PH.D. (LOND.)
O) Crossfield, Arthur, B.SC. (LOND.), A.M.INST.PET.
OF) Daruwalla, Erach Hormasji, B.SC., M.SC.TECH. (BOM.), PH.D. (MAN.)
P) Dickinson, Denis Ridgwell, B.SC. (LOND.), DIP.CHEM.ENG., A.M.I.CHEM.E.
P) Evered, Derek Frank, M.SC., PH.D. (LOND.), M.A. (CANTAB.)
OG) Gollakota, Gopala Krishnamurty, B.SC. (AND.) PH.D. (MINN.)
H) Harrison, Douglas, B.SC., PH.D. (LOND.)
P) Hyde, Cyril Walter, B.SC. (LOND.)
O) Kin, Leslie, A.M.INST.PET.
N) Lewis, Donald George, B.SC., PH.D. (LOND.), D.I.C.
P) McGhee, Malcolm Aloysius Cameron, B.SC., DIP.ED. (GLAS.)
J) MacLean, James Alistair Ross, B.SC., PH.D. (EDIN.), M.I.BIOL.
Mardon, James, M.A. (CANTAB.), A.M.INST.F.
M) Milton, Harry Eric, B.SC. (NOTT.)
OD) Rajagopalan, Srinivasa, D.SC. (AND.)
P) Reid, Frank Herbert, B.SC. (LOND.)
OE) Sastry, Aradhyula Sambasiva, B.SC. (AND.), M.SC. (BOM.)
N) Styan, George Eric, B.SC. (LOND.), F.S.D.C.
N) Taylor, Harry, B.SC., PH.D. (LOND.), F.P.S.
P) Tutt, Derek Edward, B.SC. (LOND.)
N) Weston, Gordon John, M.A. (OXON.)
Q) Wilson, Robert Douglas, B.SC. (EDIN.), F.H.-W.C.
A) Youngson, George William, B.SC., PH.D. (ABERD.)

NEW ASSOCIATES

P) Athawale, Vasant Dattatraya, B.SC. (AGRA)
P) Bhasin, Rattan Lal, B.SC., M.SC.TECH. (PANJ.), PH.D. (BIRM.)
N) Briske, Claude, B.SC., PH.D. (LEEDS)
Chan, Sai Cheung, M.SC. (H.K.)
H) Coldrey, James Michael, B.SC., PH.D. (NOTT.)
OG) Deorha, Daleep Singh, M.SC., PH.D. (AGRA)
OE) George Samuel, Peter Christopher Dharmaraj, B.SC. (MADR.)
OD) Hafeez, M. Mohamed, B.SC. (MYS.), A.R.C.S.T. (GLAS.), DR.RER.NAT. (BRAUNSCHWEIG)
Q) Howard, George Derek, B.SC. (SHEFF.)
T) Hussey, James Joseph, B.SC. (MANC.)
OE) Lakshminarayanan, Ramaiya, B.SC., B.SC.TECH. (MADR.)
OF) Mathur, Rajendraprasad Mataprasad, B.SC., B.SC.TECH., PH.D. (BOM.)
Newbold, Professor Brian Trevor, B.SC. (MANC.), D.SC. (LAVAL)
O) Roach, Albert George, B.SC. (WALES), PH.D. (MANC.)
OH) Roy, Ashitendu, B.SC. (CALC.), A.R.C.S.T. (GLAS.)
OF) Shenoy, Venkatraya B. Gopal, B.SC., B.SC.TECH. (BOM.), M.S. (MARYLAND)
OG) Singh, Ranbir, B.SC. (AGRA.), M.SC. (RAJPUT.), PH.D. (BAN.)
(J) Taylor, Kathleen Birmingham, B.SC. (EDIN.)
(OA) Venkatachalam, Ramasamy, B.SC., M.A. (ANNAM.)
(U) Williams, Michael John Ghent, B.SC., PH.D. (SHEFF.)

GRADUATE MEMBERS ELECTED TO THE ASSOCIATESHIP

(S) Adamson, Robert Selby, B.SC.AGRIC. (DUNELM.)
(P) Barrett, Sidney William, A.M.INST.S.P.
(P) Blunt, Geoffrey Vincent Dallow, A.C.T. (BIRM.)
Goodgame, David Martin Lawrence, B.A., B.SC., D.PHIL. (OXON.)
(P) Halliday, Derek, B.SC. (WALES)
(O) Hateley, Roger John, B.SC. (LIV.)
Jeffery, John William Oliver, B.SC. (LOND.)
(R) Kirby, Sheila Ann, B.SC. (S'TON)
(C) Rees, David Islwyn, M.SC.(WALES)
(P) Selway, Rupert Aleck
(D) Sheppard, Michael Lewis
(Q) Thompson, Walter Keith
(P) Tice, Brenda Barbara Pauline, B.SC. (LOND.)

NEW GRADUATE MEMBERS

(K) Brown, Colin Macarthur, A.R.C.S.T. (GLAS.)
(P) Clarkson, Michael John, B.SC. (GLAS.)
(V) Hughes, Martin Neville, B.SC. (SWANSEA)
(P) Johnson, Robert Edward Walroos, B.SC. (LOND.)
(K) Leask, Ronald Graham Smith, B.SC. (GLAS.), M.B., CH.B. (GLAS.)
(N) Manchester, Cora Rosemary, B.SC. (LOND.)
(P) Otisi, Agwu Otisi Agwu, A.R.C.S.T. (GLAS.)
(P) Peterson, William Geoffrey, B.SC. (LOND.)
(P) Poulson, Peter Brian, B.A. (CANTAB.)
(P) Ray, Terence Clive, B.SC. (SWANSEA)
(U) Remmer, Briar, B.SC. (LIV.)
(J) Sandie, Robert Raeburn, A.H.-W.C. (EDIN.)
(J) Vass, John David Ritchie, B.SC. (EDIN.)

DEATHS

Fellows

(E) Boehm, Erich, DR PHIL. (BERLIN). Died 28 December, 1959, aged 61. *F.* 1946.
(P) Chick, Oliver. Died 2 January, 1960, aged 74. *A.* 1919, *F.* 1927.
(P) Dewhurst, Milton, B.SC.(MANC.). Died 22 December, 1959, aged 61. *A.* 1921, *F.* 1943.
(E) Falconer, William Alexander, B.SC. (GLAS.). Died 23 January, 1960, aged 59. *A.* 1923, *F.* 1950.
(F) Fearon, William Robert, B.A. (CANTAB.), M.A., M.B., SC.D. (DUB.). Died 27 December, 1959, aged 67. *A.* 1917, *F.* 1921.
(G) Owen, Owen, M.SC. (WALES), PH.D. (LOND.). Died 8 January, 1960, aged 63. *A.* 1921, *F.* 1944.
(P) Pepper, Albert Cecil, B.SC., PH.D. (LOND.). Died 21 December, 1959, aged 45. *A.* 1938, *F.* 1945.
(P) Ridge, Bertram Pusey, B.SC., PH.D. (LOND.). Died 9 January, 1960, aged 66. *A.* 1921, *F.* 1926.
(X) Rule, Alexander, M.B.E., PH.D. (JENA), D.SC. (LIV.). Died 12 January, 1960, aged 79. *F.* 1919.
(P) Spilman, George Herbert. Died 22 December, 1959, aged 71. *A.* 1918, *F.* 1943.
(O) Turner, Kenneth, M.SC., PH.D. (SHEFF.). Died 11 January, 1960, aged 52. *A.* 1942, *F.* 1945.
(P) Walker, Frederick George Cannon, M.C. Died 7 January, 1960, aged 77. *A.* 1912, *F.* 1916.
(P) Walker, John Howard, M.A., B.SC. (OXON.). Died 11 January, 1960, aged 49. *A.* 1949, *F.*, 1959.
(P) Widdows, Sibyl Taite, B.SC. (LOND.). Died 4 January, 1960, aged 83. *F.* 1918.

Associate

(P) Lancaster, Joan Mary, B.SC. (LOND.). Died 3 January, 1960, aged 48. *A.* 1950.

Student Members

(O) Ellwood, William John. Died 24 December, 1959, aged 31.
(Q) Hobson, Alan Norman. Died 23 December, 1959, aged 21.

LOCAL SECTIONS OF THE INSTITUTE

DIARY OF MEETINGS

Sections are glad to welcome members of other Sections to their meetings and social functions, except when numbers are restricted, as for works visits. Those wishing to attend meetings outside their own area are advised to write to the Hon. Secretary of the Section concerned, as the Institute cannot accept responsibility for any alterations or cancellations. All times are p.m. except where otherwise stated.

(A) **Aberdeen.** 16 Mar. 8. Complexometric Methods of Analysis—Metals and Non-Metals. Dr T. S. West. University Union. Joint, C.S., S.C.I.

(B) **Belfast.** 15 Mar. 7.15. Some Mechano-Chemical Effects in Corrosion. Dr T. P. Hoar. Chem. Lect. Theatre, Queen's University, Stranmillis Road

(X) **Billingham.** 24 Mar. 8. Organic Chemistry of Ferrocene. Prof. P. L. Pauson. Stockton and Billingham Technical College. Joint, C.S.

(C) **Birmingham.** 5, 12, 19 and 26 Mar. 9.30 a.m. (10 a.m. on 26th). Spring Lecture Course: Developments in Analytical Chemistry. College of Advanced Technology, Gosta Green

—— 17 Mar. 6.30. An Aspect of Fatty Acid Chemistry. Dr F. D. Gunstone. College of Advanced Technology, Gosta Green

—— 30 Mar. 6.30. A.G.M. College of Advanced Technology, Gosta Green

(SS) **Blackburn.** 31 Mar. 7.30. A.G.M. followed by lecture on Wines. G. Osgood. Technical College

(N) **Bradford.** 14 Mar. 6.45. Stereochemistry and the Stability of Metal Complexes. Dr F. J. C. Rossotti. Institute of Technology.

(D) **Bristol.** 17 Mar. 6.30. X-ray Fluorescence Analysis. J. R. Stansfield. Chem. Dept, The University, Woodland Road

(E) **Cardiff.** 25 Feb. 7. Ladies' Night: Fashion Show and Demonstration by British Nylon Spinners. Royal Hotel. Joint, S.C.I.

(P) **Chatham.** 3 Mar. 7. The Use of Platinum Catalysts in Petroleum Refining. Dr J. M. Pirrie and H. Connor. Medway College of Technology, Maidstone Road

(P) **Chelsea.** 9 Mar. 6.30. Surface Chemistry. Dr K. G. A. Pankhurst. College of Science and Technology, Manresa Road, S.W.3. Joint, College Chem. Soc.

(O) **Chester.** 3 Mar. 7.30. Agricultural Chemicals. J. L. Hunt. Public Library, St John Street. Joint, Inst. Pet.

(G) **Colchester.** 29 Mar. 7.30. Forensic Science. Dr I. G. Holden. N.E. Essex Technical College

(T) **Connah's Quay.** 16 Mar. 7.30. English—The Scientist's Servant or Master, or Both. A. L. Bacharach. Flintshire Technical College

(P) **Dartford.** 31 Mar. 7. Film Show. N.W. Kent College of Technology, Miskin Road

(F) **Dublin.** 16 Mar. 7.45. The Durability of Timber and its Enhancement by Chemical Treatment. Dr W. P. K. Findlay. University College. Joint, S.C.I.

—— 30 Mar. 7.45. The Physico-Chemical Investigation of Some Inorganic Complexes. Dr W. J. Davis. Trinity College

(FF) **Dundee.** 18 Mar. 7.15. Scientific Control in Confectionery Manufacture. D. R. Brown. Technical College

(O) **Eastham.** 10 Mar. 7.30. Some Observations on Analytical Chemistry. Dr J. Haslam. Carlett Park College of Further Education. Joint, S.C.I.

(J) **Edinburgh.** 17 Mar. 7.30. Three short papers. Dr J. W. Baynham, J. Saunders and Dr D. M. W. Anderson. North British Hotel. Joint, C.S. and S.C.I.

—— 31 Mar. 7.30. A.G.M. North British Hotel

(W) **Exeter.** 25 Mar. 4. A.G.M. followed by an address. E. Le Q. Herbert. Washington Singer Laboratories

(K) **Glasgow.** 11 Mar. 7. A.G.M. followed by Film Show. Room 24, Royal College of Science and Technology

(WW) **Grangemouth.** 17 Mar. 7.30. Colour. D. A. Downey. Recreation Hall, B.P. Refinery. Joint, Inst. Pet.

(P) **Hatfield.** 8 Mar. 7. Science in the Detection of Crime. Dr I. G. Holden. Technical College, Roe Green

(L) **Huddersfield.** 8 Mar. 7.30. Paper Chromatography of Dyestuffs. J. C. Brown. Silvio's Restaurant, Westgate. Joint, Soc. Dyers and Colourists

—— 25 Mar. 6.45. A.G.M. followed by Physical Chemistry in Organic Chemicals Industry. Dr D. S. Davies. Alexandra Chambers, John William Street

(M) **Hull.** 4 Mar. 7. Annual Dinner and Dance. New York Hotel.

—— 11 Mar. 7.30. Chemotherapy. Dr F. L. Rose. The University

(O) **Liverpool.** 11 Mar. 7. Annual Dinner and Social. G. H. Lee's Restaurant, Basnett Street

(P) **London.** 5 Mar. 7.30. Buffet Dance. Caxton Hall, S.W.1. Joint, S.C.I.

—— 16 Mar. 6. High Temperature Reactions Involving Condensed Phases. Prof. F. D. Richardson. University College, Gower Street, W.C.1. Joint, S.C.I.

(Q) **Manchester.** 24 Mar. 10.30 a.m. Symposium on Olefines in the Petroleum Industry. The University. Joint, C.S., S.C.I. and Inst. Pet.

(S) **Newcastle.** 4 Mar. 6. The Biogenesis of Porphyrins. Prof. A. Neuberger. Chem. Dept., King's College. Joint, C.S.

(E) **Newport.** 16 Mar. 7. The Selection of Management for the Chemical Industry. J. E. V. Tysack. King's Head Hotel. Joint, S.C.I.

(H) **Nottingham.** 24 Mar. 7.30. A.G.M. followed by Cancer Research. Dr B. W. Langley. Notts and District Technical College

(R) **Poole.** 26 Feb. 7.30. Living Material as a Factory. Dr C. W. Parr. Generating Station. Joint, Poole Technical Group

(Q) **Rochdale.** 9 Mar. 7.15. Some of the Newer Metals and their Application. E. Foley. Technical College, Nelson Street

(FF) **St Andrews.** 26 Feb. 5.15. Chemistry of Poisoning. Dr A. S. Curry. The University. Joint, University Chem. Soc.

(O) **St Helens.** 24 Mar. 7. Glass and the Periodic Table. Dr A. Cousen. Technical College

(R) **Salisbury.** 9 Mar. 7.45. Rubber Adhesives. H. J. Chard. Cathedral Hotel. Joint, Instn Rubber Ind.

—— 24 Mar. 7.45. Chemical Aids to Better Crops. G. L. Baldit. Cathedral Hotel. Joint, Salisbury Field Club

(O & EE) **Seascale.** 18 Mar. 8. Semiconducting Compounds and their Applications. Dr D. A. Wright. Windscale Club. Joint, S.C.I.

(R) **Southampton.** 11 Mar. 5. Some Problems of Phosphonitrilic Chemistry. Dr N. L. Paddock. The University. Joint, C.S. and University Chem. Soc.

(R) **Southsea.** 17 Mar. 7.30. Recent Advances in Antibiotics Research. Dr Lamb. Royal Beach Hotel. Joint, Portsmouth Chem. and Pharm. Socs.

(C) **Stoke-on-Trent.** 10 Mar. 7.30. Stereochemistry of Complex Metal Halides. Prof. R. S. Nyholm. North Staffs. Technical College

(V) **Swansea.** 11 Mar. 6.30. Advantages and Disadvantages of Visual Colorimetry. G. J. Chamberlain. University College. Joint, S.A.C.

(P) **West Ham.** 3 Mar. 6.30. A Chemist's Thoughts on Chemotherapy. Dr H. J. Barber. College of Technology, Romford Road, E.15

(EE) **Whitehaven.** 25 Feb. 7.45. Inorganic Stereochemistry. Prof. R. S. Nyholm. College of Further Education, Flatt Walks

(O) **Widnes.** 1 Mar. 7. Some Recent Advances in Gas-Phase Oxidation. Dr C. F. H. Tipper. Technical College

(T) **Wrexham.** 24 Feb. 7.30. Substituent Effects in some Electrophilic Aromatic Substitutions. Dr C. Eaborn. Denbighshire Technical College

HON. SECRETARIES (GREAT BRITAIN AND IRELAND)

	Section	*Hon. Secretary*
(A)	Aberdeen and North of Scotland	**P. N. Hobson**, B.SC., PH.D., F.R.I.C., Rowett Research Institute, Bucksburn, Aberdeen
(B)	Belfast and District	**R. J. Magee**, M.SC., PH.D., A.R.I.C., 255, Holywood Road, Belfast
(C)	Birmingham and Midlands	**J. E. Gregory**, B.SC., PH.D., F.R.I.C., 5, Silvermead Road, Sutton Coldfield.
(D)	Bristol and District	**R. W. Bolland**, B.SC., PH.D., F.R.I.C., College of Technology, Ashley Down, Bristol 7
(E)	Cardiff and District	**R. F. Stephens**, F.R.I.C., Skelmorlie, Stow Park Circle, Newport, Mon.
(EE)	Cumberland and District	**A. Taylor**, B.SC., PH.D., A.R.I.C., 21, Santon Way, Seascale, Cumberland
(F)	Dublin and District	**J. T. O'Herlihy**, B.SC., F.R.I.C., 21, Ballymun Avenue, Ballymun, Dublin
(FF)	Dundee and District	**K. R. Hargreaves**, B.SC., PH.D., F.R.I.C., Chemistry Department, The Technical College, Bell Street, Dundee
(G)	East Anglia	**H. F. Bamford**, M.A., F.R.I.C., John Mackintosh & Sons, Ltd (Caley Branch), Chapel-field Works, Norwich
(H)	East Midlands	**E. R. Pike**, F.R.I.C., 225, Markfield Lane, Markfield, Leics.
(J)	Edinburgh and East of Scotland	**K. A. Scott**, A.R.I.C., Department of Chemistry, Heriot-Watt College, Chambers Street, Edinburgh, 8
(K)	Glasgow and West of Scotland	**W. Gibb**, B.SC., PH.D., A.R.T.C., A.M.INST.F., A.R.I.C., Department of Technical Chemistry, Royal College of Science and Technology, George Street, Glasgow, C.1
(L)	Huddersfield	**R. R. Pritchard**, B.SC., PH.D., A.R.I.C., 16, Ripon Avenue, Fartown, Huddersfield
(M)	Hull and District	**L. Malin**, B.SC., A.R.I.C., The Universal Oil Co. Ltd, Oak Road, Newland, Hull
(N)	Leeds Area	**W. A. Wightman**, M.A., F.R.I.C., The University, Leeds, 2
(O)	Liverpool and North-Western	**J. Ashley-Jones**, F.R.I.C., c/o J. Bibby & Sons, Ltd, Great Howard Street, Liverpool, 3
(P)	London	**G. C. Ackroyd**, B.SC., A.R.I.C., 2nd Floor, 107 Cheapside, London, E.C.2
(Q)	Manchester and District	**R. Shackleton**, F.R.I.C., Magnesium Elektron Ltd, P.O. Box No. 6, Clifton Junction, Manchester
(R)	Mid-Southern Counties	**L. C. Thomas**, B.SC., F.R.I.C., 65, St Francis Road, Salisbury, Wilts.
(S)	Newcastle upon Tyne and North-East Coast	**H. L. Hutton**, B.SC., F.R.I.C., 26, Long Close Road, Hamsterley Mill Estate, Rowlands Gill, Co. Durham
(SS)	North Lancashire	**R. E. Wilson**, B.SC., A.R.I.C., 315, Blackpool Road, Preston, Lancs.
(T)	North Wales	**S. McLintock**, B.SC., F.R.I.C., Chemistry and Metallurgy Dept, Flintshire Technical College, Connah's Quay, Nr Chester
(U)	Sheffield, South Yorkshire and North Midlands	**J. D. Hobson**, B.SC., PH.D., A.MET., A.I.M., F.R.I.C., 38, Springfield Avenue, Mill-houses, Sheffield, 7
(V)	South Wales	**E. E. Ayling**, M.SC., F.R.I.C., University College, Singleton Park, Swansea
(W)	South-Western Counties	**B. M. Dougall**, M.SC.AGRIC., F.G.S., A.R.I.C., Chemistry Dept, Seale-Hayne Agricultural College, Newton Abbot, Devon
(WW)	Stirlingshire and District	**R. W. Rae**, A.H.-W.C., A.R.I.C., Nappyfaulds House, By Falkirk, Stirlingshire
(X)	Tees-side	**G. H. Mansfield**, B.SC., PH.D., A.R.I.C., 86, Harlsey Road, Hartburn, Stockton-on-Tees, Co. Durham
(Y)	Thames Valley	**E. S. Lane**, B.SC., PH.D., F.R.I.C., Building 429, Chemistry Division, A.E.R.E., Harwell